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HEATING AND VENTILATING

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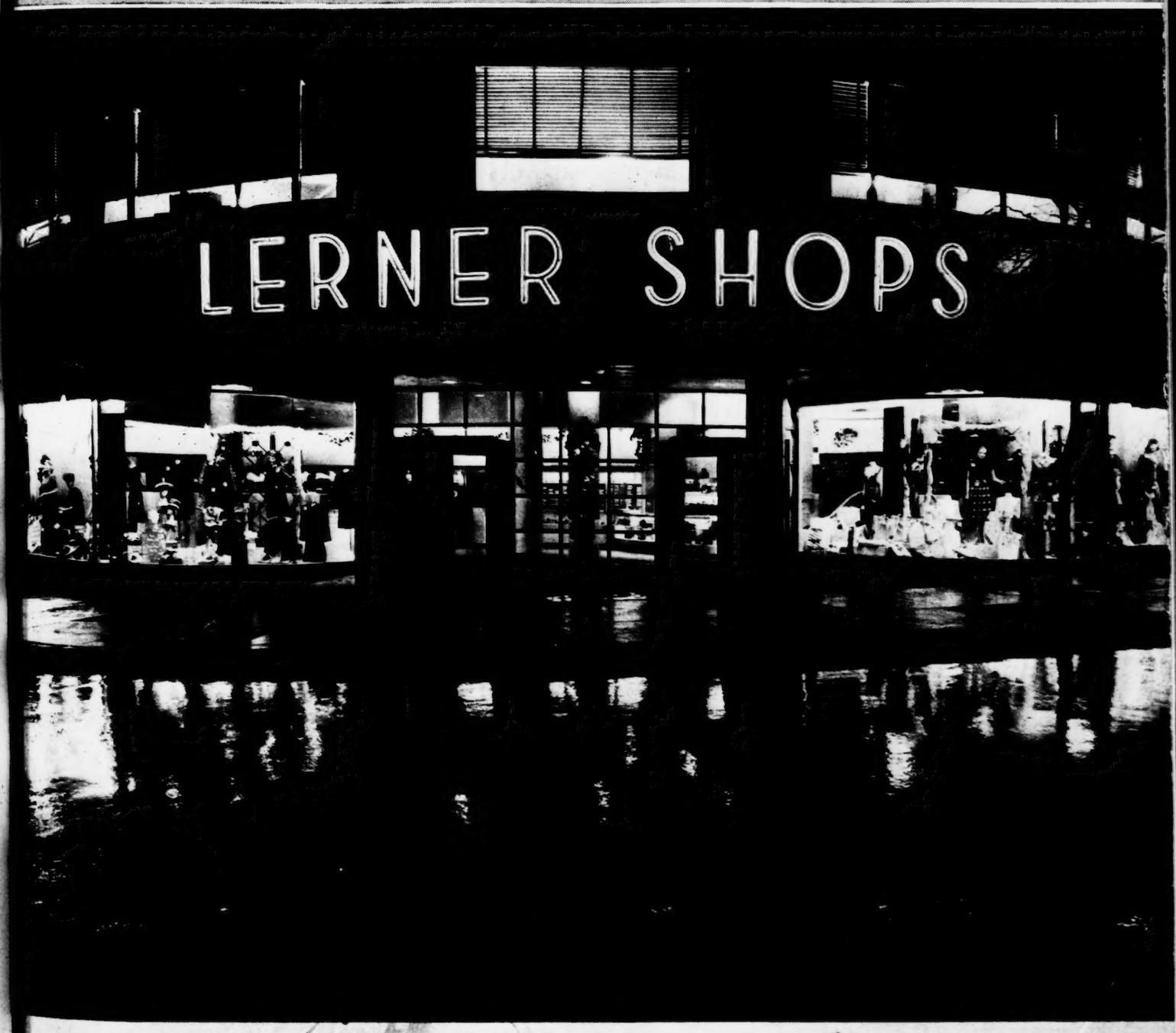
AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION



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Analysis of Fan Noises . . page 69

Ventilation of Solvent Degreasers . . . . . page 72

Pipe Offset Calculations . . page 76

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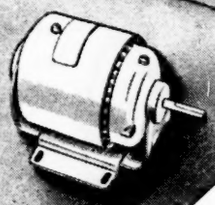

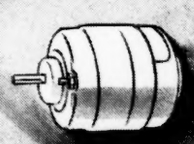

REDMOND

VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

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THIS MONTH'S COVER

Pictured is the Parkchester development's Lerner Shop illustrating how wide glass areas and window backs opening to the store increase heating and cooling loads as discussed in the article beginning page 65.

A THOUSAND COILS
to meet a thousand needs

Standard Trane Coils are available in any number of sizes and styles to meet a broad range of requirements. Construction methods are so flexible that the most rigid specifications can customarily be met to produce a coil of practically any size or shape.

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Trane Heating Coils are designed for use with either steam, hot water, or other liquids. Trane Cooling Coils are designed for use with chilled water, cold well water, or direct expansion refrigerants. Some coils are designed for dual service—cooling in summer and heating in winter.

Standard Trane Coils are widely used as built-in heat exchangers for other equipment, such as generator cooling coils, air condenser coils, gas cooling coils, gas vaporizing coils, transformer oil cooling coils and many others.

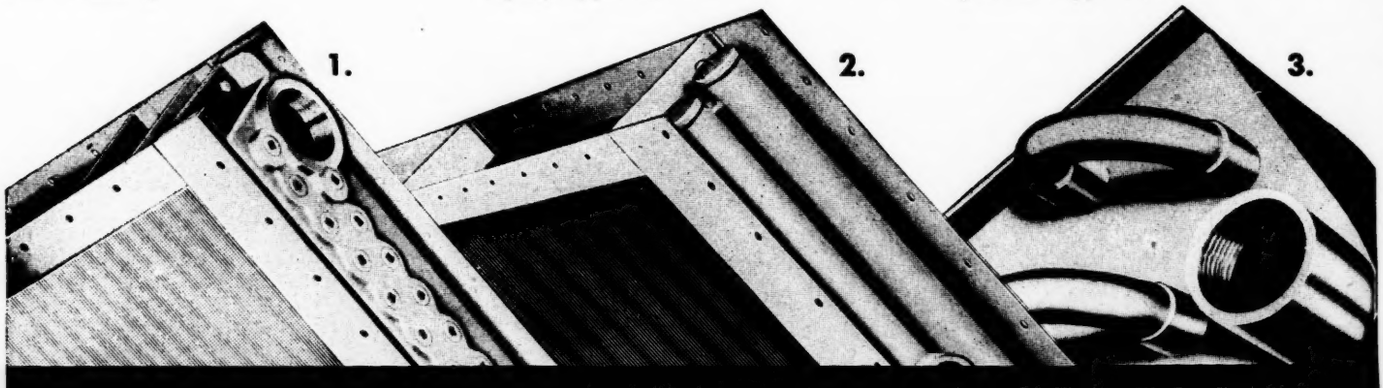
All Trane fin-and-tube type Coils,

HEATING
See Trane Bulletin
DS-385

1. Trane SD Coil. A typical Trane Heating Coil is this steam distributing tube coil that prevents stratification and freeze-up.

2. Trane WH Coil. Has all welded construction to withstand higher pressures so often found in process heating and drying applications.

3. Trane Laundry Coil. Creates warm air for drying in laundry tumblers made by others. Typical of many special application type coils.



TRANE COILS

HEATING • COOLING • COMFORT PROCESS
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Washington News

LORING F. OVERMAN

Steel Strike and Shortages.
Watch New Commerce Dept. Unit.
New 1946 Building Forecast.
Availability of H&V Equipment.
Veterans and Construction.

IN going to press at the height of the steel strike, this column makes bold to observe that perhaps it is well that official Washington is a city of optimists.

Dusting itself off after being jarred completely out of the saddle by the Steelers for the first time since Pearl Harbor, that segment of Washington charged with settling such affairs seemed merely to be observing, "They can't do this to us—or can they?"

A few, dwelling on the latter possibility, shuddered to think of the possible effects of a drawn-out stoppage of output by an industry which could, in turn, shut down 40% of the nation's manufacturing enterprises. In the main, however, Washington appeared to be making its plans on the assumption that public opinion would force a settlement of the controversey at a date earlier than the public declarations of the principals would indicate.

It should not be inferred that Washington discounted the seriousness of the situation. On the contrary, it was merely concluding that a work stoppage having so many ramifications would soon affect so many people that public clamor would either force capitulation or back up government in any strong action it might conclude was necessary.

General Strike Recalled

Some commented that an extended steel strike could soon result in a situation similar to that in England some years ago. There everyone decided to quit work at once, and within 48 hours everyone got tired of finding no stores or cafes open, no streetcars or busses running, no elevators, no heat, no hot water, no nothing. So England went back to work.

Washington believes that America is going back to work, too, and soon, and it appeared more concerned with possible long-range effects of the steel strike than with the fact that steel companies and unions weren't even on speaking terms.

CPA Enacts Cushion

To cushion the over-all effect of the stoppage of steel production, the Civilian Production Administration immediately suspended all existing preference ratings for steel. Distributors were placed under more or less voluntary controls and CPA retained the right to issue specific written directives to producers or distributors requiring the filling of an order from stocks on hand if limited quantities are essential to public health or safety. It may also assign an AAA rating, valid only against distributors' stocks and not to be extended to producers, for emergency needs of public utilities, fire and police departments, hospitals, railroads, food processing and so on.

Long-Range Shortage Forecast

That it was not taking the steel strike lightly was indicated by an Office of War Mobilization and Reconversion appraisal of probable results following settlement of the strike. Warning that each day's stoppage cut more deeply into its estimates, OWMR estimated that even the best efforts of the industry would be insufficient to meet indicated demands for 1946. Steel productive capacity for 1944 was 67 million tons, compared with a 1940 production of 49 million. Capacity for 1946 is estimated at only 60 million, while actual production will be off by at least the amount represented by the man-hours lost during the strike.

The drop in productive capacity is reported by OWMR as due to elimination of some special war production facilities, plant renovations, retirement of obsolete or marginal production facilities and a decline in steel castings output. Total demand is expected to just about balance capacity, with demand for certain forms and sizes far in excess of facilities to produce them.

The steel strike will aggravate shortages already forecast for the first half of this year in flat rolled steel products, causing such shortages to spill over into the second half, when it had been anticipated demand and supply might level off.

Looking ahead into 1947 and beyond, OWMR questions the adequacy of the country's steel capacity to meet the need for construction materials, capital goods, and consumers' durable goods. It should be remembered, the report comments, that wartime production peaks in steel tonnage included armor plate and numerous shapes and forms for munitions. Some of the production facilities capable of turning out these war-needed types of steel cannot be adapted to peacetime needs.

"Unless the capacity of the steel industry is expanded during 1946 and 1947," the report concludes, "it may become a bottleneck which will delay the increase of production to full employment levels."

Commerce Unit Expands

Another government sub-division that is making its plans with only one eye on current strikes is the newly-formed Construction Practices Unit of the also-new Construction Division of the Department of Commerce. Pending budget authorization by Congress, the Construction Practices Unit is somewhat skeletonized but its projected program bears watching by those within the heating, ventilating and air conditioning industries.

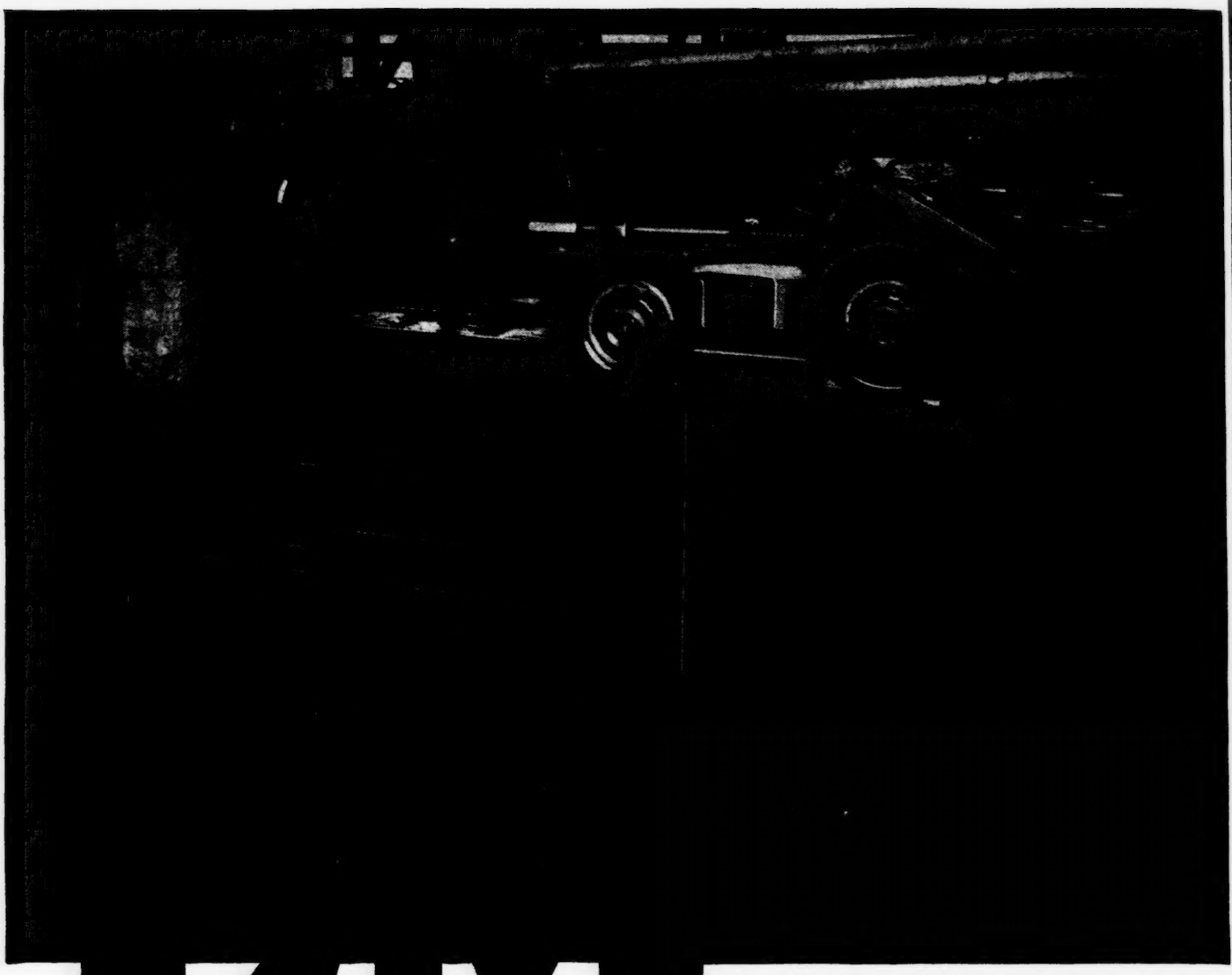
The new Unit of the Construction Division is headed by J. Marshall Mays, transferred to the Department of Commerce during January after serving as Director of Materials Requirements for the National Housing Agency. During the war Mr. Mays acted as a liaison executive in coordinating requirements of NHA with those of war agencies placing their claims for scarce building materials.

Before pointing out the specific functions to be assigned to the new Construction Practices Unit, it may be well to review the purposes for which the Department of Commerce Construction Division was formed on September 24, 1945. It was intended as somewhat of an answer to the layman's frequent question, "Now that the War Production Board is shutting up shop, will there be any place in Washington where I can find, under one roof, everything the government knows about the building industry?"

Industry Clearinghouse

As explained by John L. Haynes, Chief of the Division and former Director of the WPB Construction Bureau, it will be the primary purpose of the division to organize and synthesize information pertaining to the construction industry from a variety of both government and private agencies, and to fashion it into a comprehensive picture of the industry as a whole. Other purposes will be to encourage a higher prewar volume of construction activity and a more even flow of building.

The program for the division was adopted after consultation with private business groups directly concerned with various phases of the construction industry.



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Plans of the division point toward an annual goal of $15 to $20 billion a year—the 10% share that the building industry must achieve if it is to maintain its prewar comparative position as a producer of national income.

The new Construction Practices Unit is expected to become industry's point of contact with the new division. It is to this unit that construction industry trade associations and individuals will be invited to bring their problems and direct their inquiries.

Docketed for early study by the unit are building codes and any restrictive practices that may be interfering with full production and employment. Working in conjunction with the Bureau of Standards, which is also under jurisdiction of the Department of Commerce, the Construction Practices Unit hopes to assist in activating many of the pending recommendations for simplification and standardization of building codes.

As a part of its efforts to assist labor by smoothing out the peaks and valleys common to the construction industry, the Unit hopes also to be able to encourage the revision of restrictive labor practices that may appear to be interfering with this objective.

Program Formulating

"Although some of our objectives are already well defined, perhaps the most important will consist of being available to assist with any project which the construction industries feel would be of assistance to them," said Mr. Mays. "The Unit will have access to a vast amount of information covering all phases of the construction industry. Without question, this data can be of material assistance to those planning the construction projects of the future."

Already in the finished stage and available for distribution is a monthly publication of the Construction Division titled, "Industry Report—Construction and Construction Materials." The report includes forecasts, monthly comparisons of construction activities, data on costs and prices, and a summary of the availability of various construction materials.

1946 Forecast Up Again

The January "Industry Report" of the Construction Division adds another $100,000,000 to the anticipated total building activity for 1946, raising the anticipated total to $7,400,000,000, of which $5,350,000,000 is expected to be privately financed. The expanded total makes allowances for possible effects of Priorities Regulation No. 33, granting preference for veterans' housing costing less than $10,000 per unit. The forecast admits, however, that "for at least the first few months the rate of advance will be conditioned by material availability and possible labor difficulties. The later months should see some easing of the current nip and tuck situation.

"Total private construction," the report continues, "is expected to reach 5,350 million dollars, 96% above the 1945 figure. Most of the gain will be concentrated in residential construction (excluding farm dwellings). Work done in this field will probably reach 2,150 million dollars, or almost three times that in 1945. This means that the goal of 500,000 nonfarm units will just about be reached.

"Private industrial construction is expected to exceed that in 1945 by 59% and other nonresidential construction by 74%. Public utility construction is expected to be up 48%.

"Total publicly financed construction in 1946 at 2,150 million dollars will exceed the 1945 total by only 6%. In make-up, however, the 1946 total will differ sharply from that of 1945. Severe declines in military and naval and publicly financed construction will be more than offset by substantial increases in highways, community facilities, and other peacetime categories. Highway construction is expected to be about 800 million dollars, 182% above 1945; sewage disposal and water supply, 300 million dollars, 209% above 1945, and other nonresidential building (hospitals, schools, etc.), 400 million dollars, 95% above 1945."

Construction Costs Up

The Construction Division's January report of construction costs, based on averages of reports covering 10 types of construction in 20 cities during November, indexes costs during that month at 132% of the base year, 1939. Wholesale prices of plumbing and heating equipment for the same month were given the index figure of 166.7% of 1939.

Following are the Division's comments regarding availability of plumbing, heating and air conditioning equipment and components:

Cast iron soil pipe and fittings. These are still in short supply owing to labor shortage in foundries. Early improvement is expected. Several idle foundries expect to resume production in the fourth quarter. Wage increases and price advances seem to be effecting production increases.

Cast iron boilers (steam and hot water). Production is low owing to labor shortage. Small house sizes are especially short. Gas-fired boilers in critically short supply.

Cast iron radiation. Production is low and stocks extremely scarce, situation not improving.

Commercial and industrial stokers. In good supply.

Convectors. Copper available, cast iron supply low.

Domestic stokers (Class B). Limited quantity available. Improvement expected. Motor shortage delaying production.

Gas conversion burners. In short supply, with limited quantity available for replacements and new installations.

Heating and combustion controls. Tight; material shortages are the bottlenecks.

Registers and grilles. In tight supply.

Steam and hot water controls and accessories. Limited stocks.

Steel boilers (high pressure). No stocks. Heavy backlog on producers' books.

Steel boilers (low pressure). In short supply. Increased production expected.

Stove and smoke pipe. In fair supply, which may diminish.

Unit Heaters. In fairly good supply.

Warm air distributing equipment. In tight supply. Sheet metal shortages delaying production.

Warm air furnaces. Coal furnaces (gravity) in fair supply. Coal furnaces (forced-air type) in tight supply. Gas- and oil-fired furnaces in extremely tight supply.

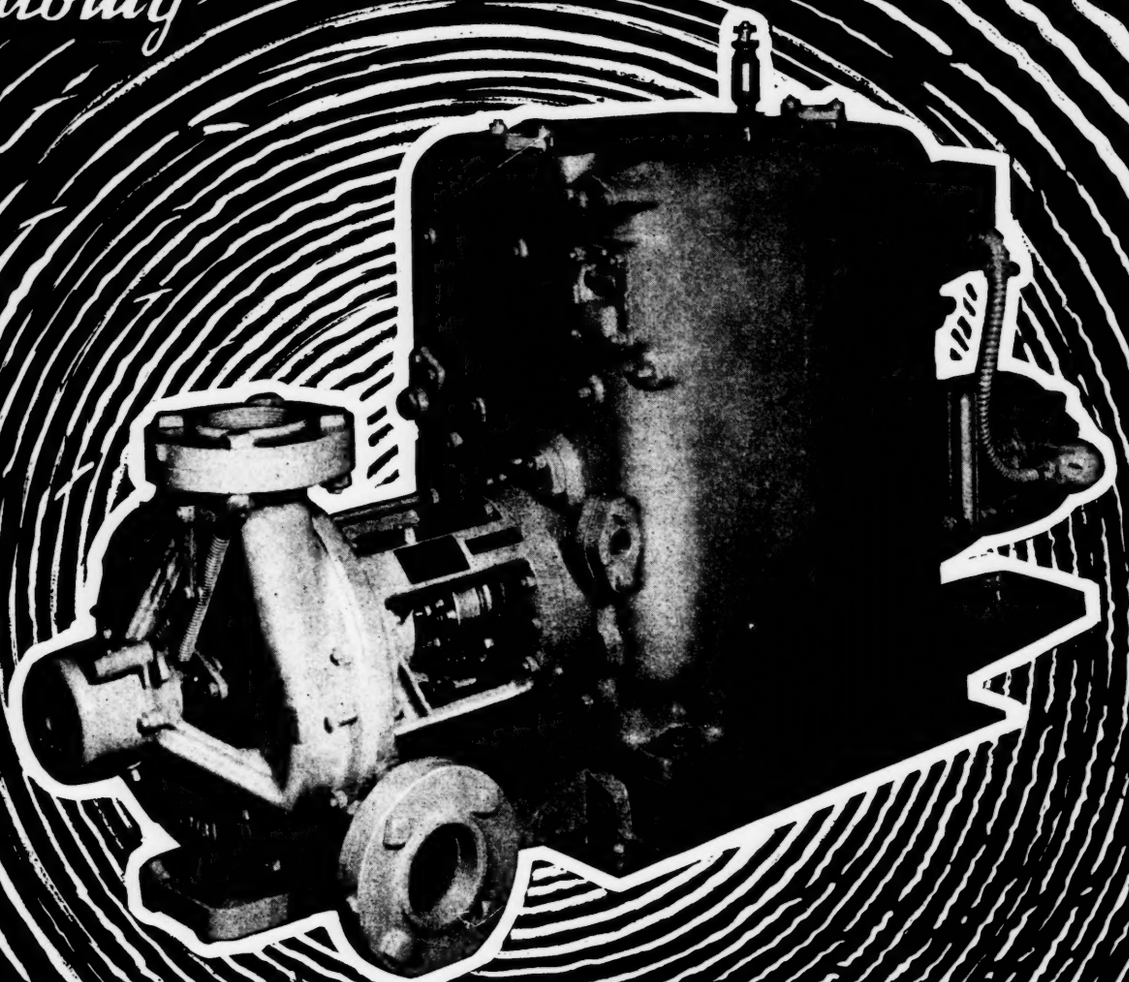
Motors. Production on small-sized alternating current motors is far below demand. Backlogs at current production rate are 12-18 months for fractional; 13 months for integral single phase; 6 months for integral polyphase. Shortages of labor and materials for all classes of motors are the problems of manufacturers. Factory stocks are practically nonexistent. Some surplus and reconditioned motors are obtainable through Reconstruction Finance Corporation and motor repair shops.

Veterans' Set-Aside Ordered

CPA has issued Directives 2, 3 and 4 to Priorities Regulation 33 (Veterans Housing) to channel bathtubs, cast iron radiation and cast iron soil pipe into the Reconversion Housing Program for Veterans. Starting with February 1, distributors and jobbers must reserve 60% of their inventories of bathtubs and soil pipe, and 70% of cast iron radiation inventories. These amounts must be held up to 21 days to fill HH rated orders. Thereafter the distributor or jobber must continue to reserve from each shipment received the same percentage for HH ratings.

Each such set-aside must be held for HH rated orders for the 21-day period, after which any of the remaining items may be sold against other rated orders, or against unrated orders in accordance with Priorities Regulation No. 1. The HH ratings are not extendable by jobbers or distributors to producers of the items.

Centralized Heating Economy



A RETURN LINE VACUUM PUMP THAT CUTS HEATING COST.

This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

More important, this pump insures absolutely uniform circulation in system. That means continuous steam economy.

Simple, compact, one moving element, no wearing parts, no internal lubrication. Bulletin No. 203 gives the facts. Your copy is waiting.

THE NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT, U. S. A.

Two focal points of modern store design are the backless show window, and the store entrance.

Air Conditioning Women's Apparel Stores

BRUCE A. JACOBI
Chief Engineer, Lerner Shops, New York, N. Y.

Women's apparel shops present air conditioning problems that must be coordinated with the latest merchandising methods in that field. Experiences gained by the Lerner Stores Corp., an organization operating 200 stores in 42 states, is summarized in this article by the company's chief engineer.

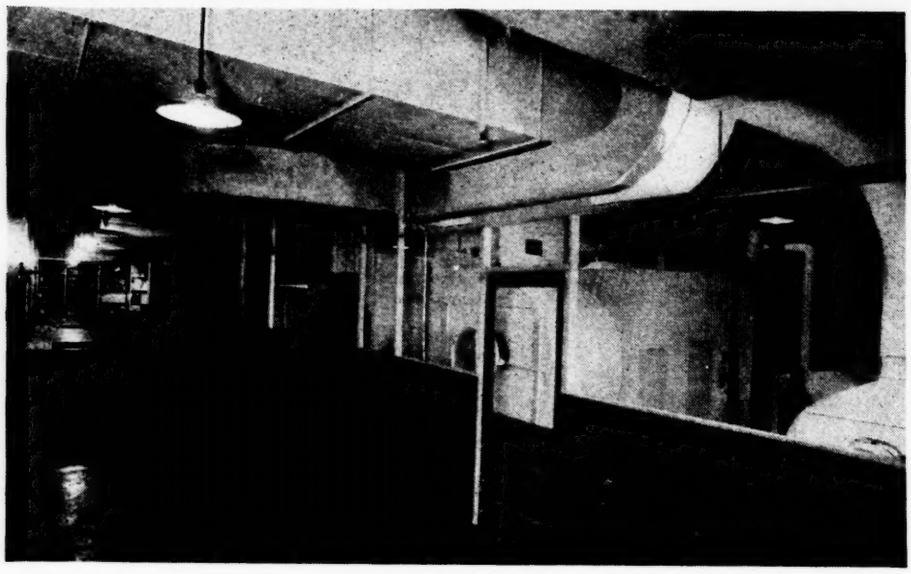
AIR conditioning a women's apparel chain store differs somewhat from an average utility shop. A woman will spend from twenty minutes to well over an hour in our stores when she purchases a dress, coat, or suit, and thus the importance of providing conditions of comfort continuously throughout the year becomes readily apparent.

Air conditioning in a women's specialty store provides comfort and an appreciable merchandise saving. Obviously by providing comfortable conditions, the customer is in a better mood for making purchases. The latter, while not universally understood, is of considerable importance. Air conditioning saves the owner of a chain store a large amount of money by preventing spoilage of clothing during the cooling season, particularly so in regions of high wet bulb areas such as are encountered along the Gulf of Mexico. Ordinarily, much merchandise would be spoiled because of perspiration and smudge stains when trying on clothing caused by a customer entering the store from oppressive outdoor conditions. A "precooled" customer who tries on a dress does not spoil clothing.

Problems encountered in designing an air conditioning system in a women's shop are numerous and interesting. Matters which often appear insignificant and unimportant require considerable attention for satisfactory operation of the heating and cooling systems.

Positive Pressure Conditions

For example, front doors offer an all too often troublesome problem. In a busy store, entrance doors are being opened practically continuously—so much so that we now calculate cooling loads based on the assumption that front doors are wide open at all times. With the doors in an open position, it becomes necessary to develop a positive air pressure at the store entrance and to provide for an exfiltration of air into the store lobby. This is usually



Air conditioning room housing the fan and cooling coils. In this Chicago installation, distributing ducts are placed in the work room corridor.

accomplished by adjusting the return air damper on the sales floor until a positive pressure condition is obtained at the store entrance. However, in a tall building, a stack effect is frequently prevalent and the return air damper adjustment in itself will not be sufficient to effect an exfiltration into the lobby.

When such a condition is encountered, a supply outlet is placed above the entrance doors on the inside of the store. The outlet is designed to deliver a sufficient quantity of air to blanket any infiltration.

Entrance Design

An interesting by-product of this type of summer operation is the semi-cooled lobby. The writer has noted in many of our Southern stores, which of course are located in commercial areas, that business girls, particularly during their lunch hour, will frequent the store lobby to obtain some comfort. The advertising value resulting from the show window displays facing the lobby is quite valuable.

For the heating season, a booster heating coil is placed in the supply duct at the entrance. This coil is controlled by a thermostat located in a representative region near the front doors. In some instances a thermostatically controlled unit heater is recessed in the wall near the entrance. Store managers do not approve of storm doors with added vestibules during the winter, contending that the increased number of doors presents a customer hazard. Therefore provision for booster heating at the front entrance is extremely important and requires considerable detail to prevent over or insufficient heating at this point.

Fitting Room

The fitting room presents a severe problem in air conditioning design because this area has a more concentrated occupancy than any other part of the store. The room is completely enclosed with a low ceiling; usually 8 ft high, and is separated from the sales area. Customers spend more time in the fitting room than in any other part of the store and a large percentage of sales is made in the fitting room cubicle.

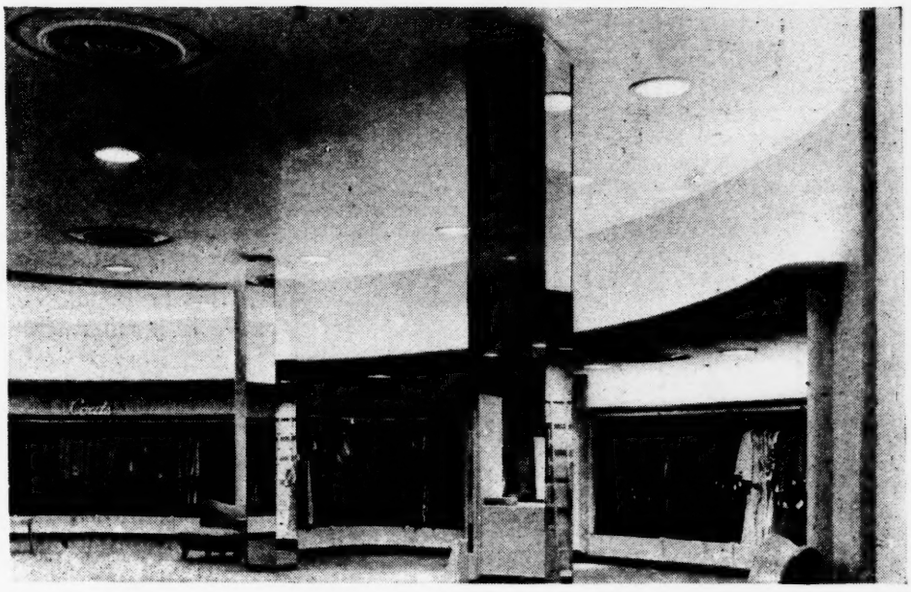
We have found it advisable to install a separate duct from the fan outlet into the fitting room area. A booster cooling coil connected to a small condensing unit is installed within this duct. A booster heating coil is also placed in the fitting room duct.

Through experience, we have found that this area normally requires a slightly higher temperature during the cooling period and also during the heating season, as compared to the general sales area. This is probably caused by the activities of customers disrobing and trying on dresses, coats and suits. Our experience indicates that there should be a two to three degree differential between the fitting room and general sales area. Moreover, because of the high occupancy concentration, a sufficient amount of outside air must be circulated to prevent odors and this air must be rapidly exhausted. We usually discard the exhaust air from the fitting room to the outside by means of a small utility type blower. It is never recirculated.

Air Distribution

Zoning is important where more than one sales floor is involved. In smaller stores, each sales floor is zoned by automatic volume dampers during the cooling season and by thermostatically controlled booster coils during the heating season.

In large stores it is usually more desirable to install a separate conditioner, complete with filters, cooling and heating coils, and fan for each floor. Economy and ease of operation are the decisive factors in determining which type of zoning to employ. Air distribution presents a different problem for each store. Hung ceilings allow for an architectural blending of store lighting with ceiling air arrangement, and this is particularly important in effecting draftless distribution. Wall type air distribution is used in our stores to a lesser degree now than ever before. Grilles installed in walls frequently interfere with the interior decorative plan. Moreover, it is the writer's contention that air outlets, like sources of light, should not be apparent to the customer and wherever possible should be hidden or placed in an obscure position.



High lighting levels with incandescent bulbs for color accuracy increase cooling load. Diffusers in ceiling promote draftless air movement.

Women in particular appear more sensitive than men to drafts and we must take special pains to avoid any type of air distribution which will result in draft. We have been able to achieve a satisfactory draftless type method of air distribution by the use of ceiling outlets as mentioned.

We have found it advisable, in designing air conditioning systems for our stores, to specify two or more parallel units, each complete in itself, rather than one large central air conditioning unit with one blower. With such an arrangement, flexibility and ease of operation are obtained. A particular advantage is obtained in case of a breakdown. Should one unit become inoperative, the others will still function and thus only a portion of the store will be without air conditioning during the breakdown period.

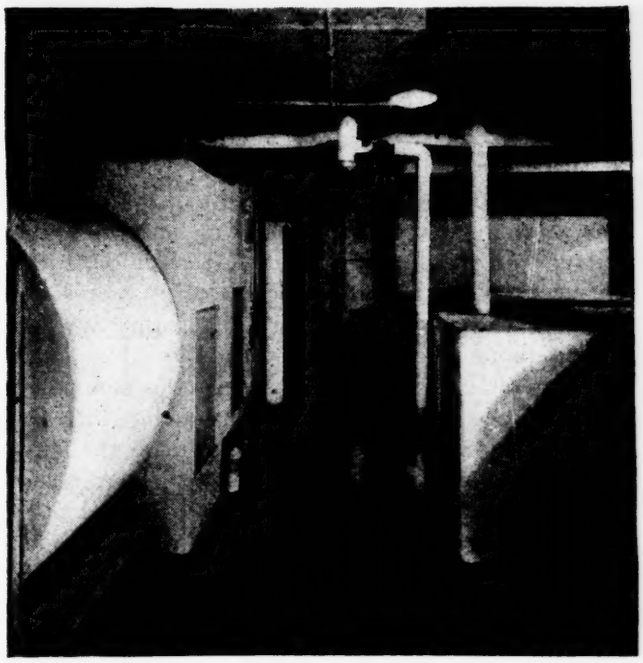
Moreover, we design the several small units so that one may be by-passed into another. If necessary, then, the air supply from one unit may be called upon to help another area with a depleted air supply. Although it is usually more expensive to install several small units, the savings for a period of years obtained through flexibility of operation and better air conditioning more than offset the initial equipment cost.

Of considerable importance is the problem of dust elimination. We have found it advisable to use a throw-away type filter, to have the filters serviced periodically, and to replace them regularly three or four times during the year. We have established a definite filter program and advise the service companies when to change filters. We in turn follow through to be sure that filters have been renewed at the time the request was made. Much of the dust entrapped by filters in our shops is lint. This causes the filters to clog more rapidly than they would normally. Therefore, we insist our service man clean the filters twice each month using a vacuum cleaner or other suitable equipment.

Overload Provisions

Since an air conditioning system does not improve with time and use, we have found it poor policy to size the cooling system to meet exactly the calculated design conditions. All our air conditioning equipment is slightly oversized and thus when inefficiencies develop due to dirt collection on coils or normal wearing of compressors, the capacity of the system will still be sufficient to meet the required load. The importance of this condition was emphasized during the war. Occupancy in our stores increased three-, four-, and five-fold and since our systems are oversized, we were able in many instances to maintain comfortable conditions with the increased occupancy load.

It is interesting at this time to point out changes in store lighting design and their relationship to air conditioning. For several years before the war, interior store lighting was designed to maintain the level of 25 to 30 foot-candles. We now design general lighting for a maintained level of 35 to 50 foot-



Air conditioning apparatus room of a Lerner store in Chicago. These two fans deliver conditioned air to each of the first and second floor sales spaces.

Heat is supplied through grille and controlled by wall thermostat.

candles. However, because of color effect, we do not use fluorescent lighting for our primary source of light, but confine it to decorative treatment. Thus, the increased lighting, which is mostly incandescent, results in larger air conditioning systems and a high sensible heat load.

Show Window Considerations

Another modern tendency in store design is the elimination of show window backing in the newer stores. Formerly a 4 in. thick insulated partition separated show windows from the main sales area. Today, in many stores which have been recently designed, these backings were eliminated and from an air conditioning point of view, two problems resulted. The entire light load in the show windows is now directly transmitted into the sales area. Normally, show windows are lighted along their periphery with about 150 watts per running foot. It can therefore be readily appreciated that elimination of the show window backing increases the tonnage load required for cooling. In addition to the lighting problem, the sun effect in many stores becomes increasingly more important. Formerly when the sun shone directly into the show windows, and an adequate backing was provided, the sun effect could be neglected in calculating the cooling load for the store. Now, however, depending upon the location of the store, the sun frequently shines directly into the sales area and the solar effect can no longer be disregarded in the design of the air conditioning system. During the heating season, we are experiencing the additional problem of increased heat loss through show windows. The recent introduction of glass of low thermal conductivity may greatly alter this condition. We have not used enough of it yet to arrive at a general conclusion.

To overcome the increased loads caused by elimination of show window backing, we are installing air conditioning outlets in the show window proper. This has proven rather successful, not only in taking care of the heat loss and gains at the source, but it provides comfort for our window trimmers and increases their efficiency considerably. Moreover, certain display materials tend to wilt under conditions of intense heat. Air conditioning eliminates this problem.

In northern climates we sometimes have show window frosting and condensation. We have eliminated this problem by providing a concealed blower and heating coil above the show window ceiling. The blower is so placed that air is directed against the show window glass surface. The air velocity with increased heat allows for a greater humidity carrying capacity in the show windows and thus prevents frost or condensation.

Maintenance and Controls

A properly organized maintenance program is important for a successful operating season. We employ a group of field service men who regularly visit each of our stores. These men contact local service companies and see that the air conditioning systems are maintained in excellent operating conditions. We negotiate a standard service contract with a reputable service company in each locality where we operate a store. This company checks the air conditioning system twice a month during the heating and cooling season. We attempt to prevent breakdowns rather than to cure them.

At regular intervals, compressors are opened and inspected, fan belts are renewed, cooling and heating coils are cleaned, cooling towers and evaporative condensers are cleaned as necessary. Boilers and gas heaters are thoroughly cleaned and serviced before each heating season. Chimneys are vacuumed once a year.

Whenever possible, all maintenance and repair work is done during the off-season period. Every effort is made to have all cooling and heating systems in perfect condition so that other than normal lubrication and inspection during the operating season, nothing else will be required.

It has often been said that an air conditioning system is no better than the controls which operate it. Basically, this is correct but in our stores there is an eternal conflict between store personnel and customers. Thus, with the controls set to satisfy the personnel, the customers are always too cool. The net result, however, is that while the controls are set to favor the customer, we try to arrive at some compromise that will please our sales personnel.

We attempt to educate the managers of all our stores so that they will know, in a lay-man manner, the principles of air conditioning equipment. We want to educate them so that they will know what to expect—or better still, what not to expect, from their comfort equipment. We instruct them to call the service company in the event of any unusual difficulty. The education program eliminates many foolish and unnecessary service calls.

Measurement of Sound

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AUDIBLE sound is a vibration having a frequency in the range to which the ear responds. The normal ear responds to frequencies in the range between 20 and 20,000 cycles per second. The most objectionable characteristic of sound is usually its intensity. Expressed analytically, the intensity of sound is proportional to the square of the amplitude of the sound wave or of the pressure caused by the sound wave. The ear, however, does not respond directly with the intensity of sound but rather responds in a logarithmic progression. That is, a sound twice as intense, or having twice the energy does not sound twice as loud. Actually it sounds only slightly louder.

Instruments known as sound or noise meters are available to measure sound in order that standards of comparison may be established. These sound meters are usually made so that the average ear's response can be determined as well as to give a reproducible measurement. One such instrument is shown in Fig. 1.

Sound meters are calibrated to read on an arbitrary intensity scale using decibels as a unit. The average ear responds to a sound intensity ranging from 0 to 140 decibels. Each decibel represents approximately the least change in sound which a person can distinguish. Each decibel increase is also approximately an equal increment of sound change. Doubling the sound energy raises the decibel reading 3 decibels.

Fig. 1. Sound meter.

The ear's response is actually much more complicated than this since its response to noises depends greatly on the frequencies involved as well as on the intensity. Sounds with frequencies predominantly low sound less loud to the ear than high frequency sound even though the sound intensity or energy is the same. This fact is very helpful in sound proofing design because the higher frequencies are more easily absorbed. Therefore, the more objectionable portions of sound are the most easily suppressed.

The decibel reading on a sound meter is a measure of the sound energy. To have less noise, it is necessary to reduce the decibel reading. Therefore, the most important measurement in sound analysis is the sound level reading in decibels. All other measurements are usually made in an effort to find the principal source of the sound. The usual procedure is to determine the sound intensity or decibel reading and then to analyze the sound and find the predominant frequencies which go to make up the total sounds.

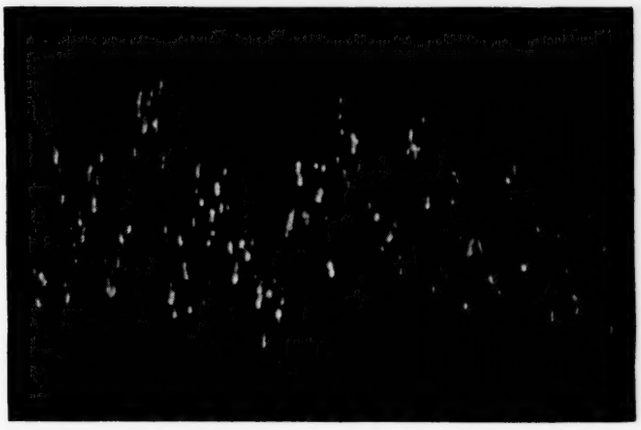

Fig. 3. Noise caused by ventilating fan.

The general character of sound can be understood most easily by referring to music. The simplest sound is a single musical note of one frequency. Fig. 2 shows a sound wave having a single frequency of 100 cycles per second. The vertical component of this wave is the amplitude of the sound and the horizontal scale is time.

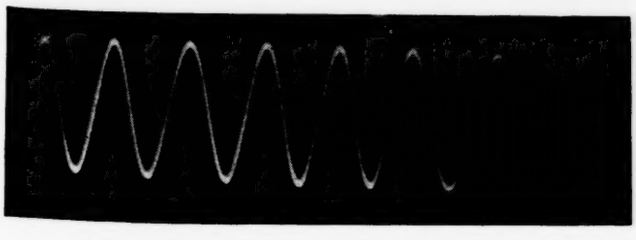

Fig. 2. Sound wave—100 cycles per second.

Most musical notes from an instrument, such as a violin string for example, have overtones or higher frequency components all bearing definite relations to one another. In most musical sounds, the lowest frequency is most important. Overtones have a smaller amplitude. When the frequencies and amplitudes are orderly as in a chord, the whole gives a pleasing sound to the ear.

The average noise is composed of many different

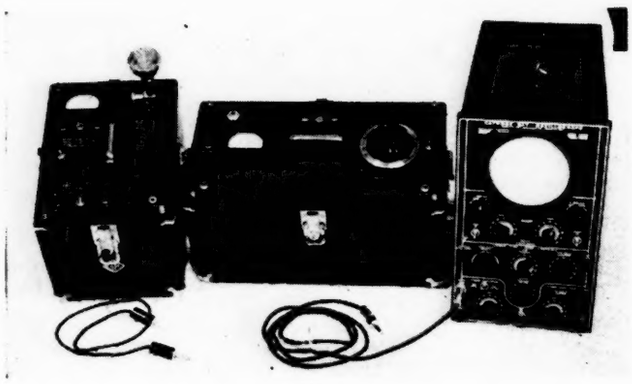

Fig. 4. Sound meter, wave analyzer and oscillograph.

frequencies and amplitudes any one of which might predominate. The frequencies usually bear no special relation to one another except as they may be related in the source. Therefore when there is no orderly arrangement we have an unpleasant sound or noise composed of a number of simple frequencies. In sound analysis it is the predominating simple frequencies that must be located and corrected. This often can be done by running machines or parts of machines separately and noticing what each contributes to the whole noise. As an example an oscillograph record (Fig. 3) of a typical noise as caused by a ventilating fan, was obtained by feeding the response of the sound meter to a cathode ray oscillograph. While the record so obtained is not particularly significant in itself, it does show that there is no apparent repetition although some frequencies might be recognized if compared with a known frequency.

By feeding the response of the sound meter into a wave analyzer it is possible to determine the frequency components of a noise and the relative amplitude of each frequency. Fig. 4 shows the complete equipment used in normal sound measuring work. It consists of a sound meter, for picking up the sound, a wave analyzer for determining the components of the sound wave, and an oscillograph for obtaining a visual picture of the sound wave. Fig. 5 shows a picture of the output of the wave analyzer as indicated on the oscillograph.

Fig. 6 is, in graphical form, the frequency analysis of the sound or noise from the ventilating fan for which records have been shown. This was a six bladed fan driven by a 1160 rpm motor. The general noise level as measured by the sound meter varied between 74 and 76 decibels. Fig. 3 indicates that there was some variation in the general sound wave. To aid in the analysis of the general sound wave four scales are shown on Fig. 6. The lower scale is the frequency of the harmonic components in cycles per second. The other three scales show the various orders of possible disturbing frequencies. The upper of these scales gives the motor frequency and its multiples. The second scale from the top shows the electrical frequency and its multiples. The point marked 1 corresponds to 60 cycles per second, that marked 2 designates 120 cycles per second, etc. The other scale shows fan blade frequencies. Since there are six blades on the fan, there are six disturbances caused each revolution of the fan rotor, a total of 6 x 1160 per minute or 116 per second. It can be seen from the diagram that the disturbances caused by the fan blades are the source of the largest noise components. The next two components are

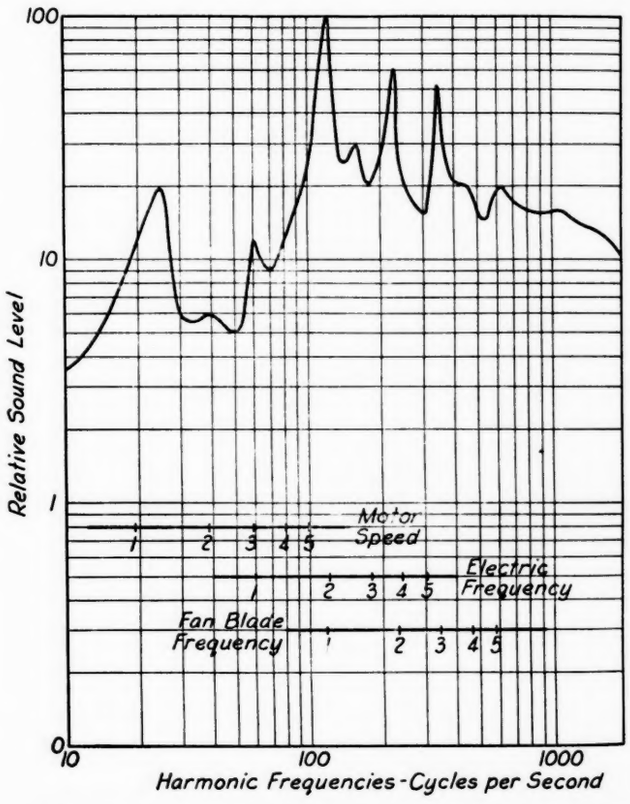

Fig. 6. Frequency analysis of ventilating fan. Characteristics are, noise level, 74-76 db; fan speed, 1160 rpm; fan blades, 6.

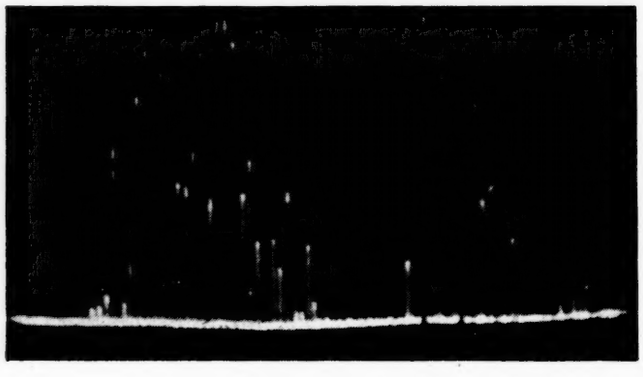

Fig. 5. Wave analyzer output as shown by an oscillograph.

caused by second and third order components of the fundamental fan blade frequency.

The application of this information to soundproofing and sound reduction design will be discussed in a future article. The information also can be applied to specific problems of a special nature. In case it is desired to eliminate vibrations of a particular frequency, Fig. 6 shows that either motor speed or the number of fan blades or their design must be changed. The diagram also indicates that reduction of the noise may be brought about through redesign of the fan blades or of the location of fan blades relative to the rest of the system.

A Problem in Air Recirculation

IN the past, particularly during the war period when quick results were of greatest importance, equipment for dust collecting was often installed without too much regard to the efficiencies of units discharging back into work rooms. Little emphasis was placed either on the actual performance of various methods or on the economics involved. The chief concern, aside from production, was removal of material at the source of generation. Perhaps the time has come to consider this matter further.

Dust collecting equipment efficiencies are not given in terms of particle count, but on a weight basis. That is, if a pound of dust is fed to a collector and 0.7 lb is retained, the efficiency is said to be 70%.

However, when the collector is installed for the protection of health, the control standards set are necessarily on a count basis rather than on a weight-efficiency basis. The concern of the industrial hygienist is with particles in a specific size range, namely from about 1 to 10 microns, a size range in which many dust collectors are not efficient; consequently, such devices have limitations in air recirculation.

To elaborate, a rated efficiency of 70% on the weight basis has little meaning in the way of protection against small particles, especially if we remember that mass varies as the cube of the dimension. Thus, a particle 100 microns in size has a mass 1000 times as great as a particle 10 microns in size, and 1,000,000 times that of a particle 1 micron in size, assuming the same densities. Therefore, the weight basis efficiency means simply that a single particle 100 microns in size is equivalent to 1,000,000 particles of 1 micron. Thus, it does not take many large particles to equal a few million small ones of hygienic significance.

The statement often made that a given collector represents the best practice available is meaningless where recirculation is involved, for it is well known that air recirculated containing more than the count specified for a healthful environment is likely, in time, to produce some form of pneumoconiosis among the workers exposed. Consequently, where small particles of hazardous dust are being handled, specific information on performance is necessary.

Manufacturers' Problems

It should be pointed out that no manufacturer of industrial dust collectors guarantees his equipment as suitable for recirculation purposes—nor, to the knowledge of the writer, is there any published information relating to the performance of a dust collector on a count basis. One reason for this probably is that the manufacturer has no standard materials or procedures available for undertaking a performance test: further, he appreciates that the many variables (concentration, particle size, rate of flow, etc.) to be found in industry in many instances vitiate the value of standard procedures. In addition, there are existing differences of opinion among experts as to the significance of a count-standard. On the other hand, the buyer with a recirculation problem where a dangerous dust is present needs definite information on efficiency means where such recirculation is practiced. The tendency by the user is to demand a better and better standard of cleaning efficiency—a trend the manufacturer himself has helped establish.

In the opinion of the writer, then, sooner or later the dust collector manufacturer must undertake some sort of a guarantee other than weight efficiency if his equipment is to be used for recirculation. It is incumbent upon his research facilities to promote investigations and studies to this end.

User's Problems

The responsibility of the user of dust collecting equipment (provided with recirculation features) to recognize the value of such equipment has often been overlooked. The user regards any piece of collecting equipment as one of "those things required by State Regulations and Labor". The equipment is frequently purchased to satisfy both, and once installed it is often nicely left alone and forgotten. In some cases it is even regarded as an illegitimate expenditure of the production process, costing money for upkeep and yielding no return. Some States (New York, for example) tacitly recognize this, and will not permit recirculation until first passed upon by a suitable board of experts.

Actually, a great many users do not understand what the dust-collecting field is about. Instead of engineering a dust job, the prospective purchaser too often looks for a bargain in the hope that, once installed, all parties will be satisfied. In fact, many users of dust-collecting equipment are unaware of the difference between count efficiency and weight efficiency.

To the user there is a definite value in air recirculation, especially in northern climates where the cost of air heating is high. Every 1000 cu ft of air heated from freezing to 72F requires 750 Btu, or, assuming the usual efficiency in heat conversion, about 0.1 lb of coal. If a dust exhaust system handles 100,000 cfm, it is not difficult to show that 7 tons of coal per day are needed to obtain a temperature differential of 40F. All this is lost on discharge to the outside.

At this point the user inquires regarding the value of recirculating to save heat. In following this through, it may never occur to him to determine the dust concentration to be handled—or if the recirculating dust concentration exceeds the established hygienic limits.

Great strides have been made in dust control during the past few years. Another step will have been made when the problem of industrial air recirculation with dust collector units is solved.

—J. M. DALLA VALLE.

Ventilation of Solvent Degreasers

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DURING the war, ventilating engineers found they frequently encountered unusual problems which had to be solved by what had been regarded formerly as unconventional methods. Such was often the case in the design of systems for the control of vapors arising from solvents used in metal degreasing. Because of the speed-up in production to meet military requirements, this type of equipments was often overloaded, with the result that machines which previously had been operated without local exhaust equipment had to be ventilated. Engineers, in a number of cases, had to use unconventional design because of the difficulty in obtaining the requisite materials.

Now that the war is over, the efficient operation of degreasers still presents a number of problems. Both during and after reconversion there will be considerable adapting of wartime equipment to peacetime use. Equipment purchased for wartime requirements will be used for applications other than those for which it was specifically designed. In some cases, this may introduce hazardous exposures which may have to be controlled by ventilation.

It is also possible that degreasing installations which required ventilation because of overloading due to production speed-ups can now be operated without ventilation. In a number of plants, location of the degreaser was determined by the available space and not by the best location for the safe operation of the degreaser. In many plants space is no longer at a premium and it will be possible to relocate the degreaser where it will not be influenced by drafts from circulating fans, unit heaters, ventilators, open doors or windows.

Therefore, when plant layouts and production are being changed it is desirable to make a careful study of the functioning of the degreaser under the new conditions. Poor design which was tolerated under emergency conditions should be eliminated for reasons of economy. Wherever possible, it is better to control the escaping vapor by changes in operation rather than by exhaust ventilation. Presence of excessive vapor in the air indicates a loss of solvent which represents unnecessary expense.

We will discuss some of the factors which should be considered in deciding whether or not a degreaser should be ventilated, and the best type of ventilation to be used.

From time to time the question arises as to whether or not ventilation is actually necessary for a

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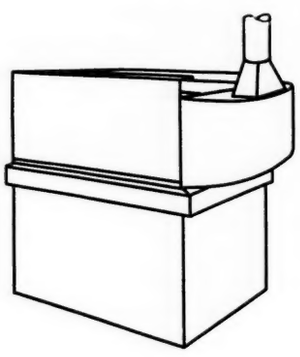


Construction
A - Slot width 1" to 2"
B - Approximately 2"
C and D as large as practicable to give minimum velocity in manifold. (not over 2000 fpm)
E - At least 2½ C

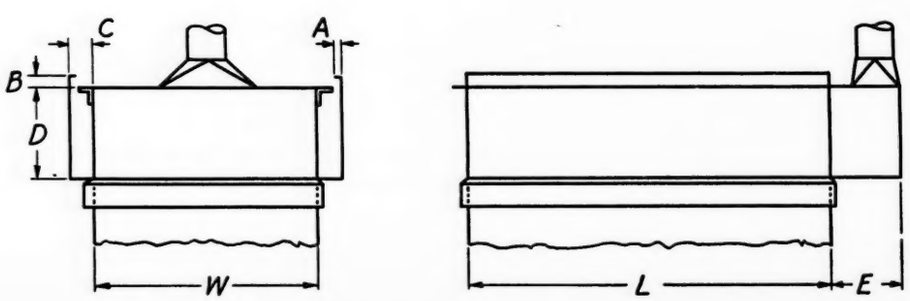


Fig. 1. Slot and manifold design. Harris, Ford, Patty and Hatch report Q = 120 (L + W); Brandt gives Q = 50LW; Witheridge and Walworth state Q = 30LW. Manifold and pipe velocities are not to exceed 2,000 fpm.

degreaser. It is often stated that ventilation is not necessary if the degreaser is properly operated, and this is generally true. However, some degreasers are not properly operated or are not used for the purpose for which they were designed, and ventilation may be required.

It has been our experience that approximately one-half the degreasers we have studied require no ventilation, while one-half of those remaining would not require it, if properly operated. Morse and Goldberg have published figures on this aspect. They found that 79.9% of samples taken at non-ventilated tanks showed 200 ppm solvent vapors or less. Degreasers may cause discomfort to the employes and in such cases it is often desirable to correct conditions in the interest of the employes' welfare.

In Massachusetts, recommendations by the State Division of Occupational Hygiene are based on the determination of the concentration of toxic solvent in the air breathed by the operator and also by a determination of the content in the urine. If the atmospheric content shows over 200 ppm. of trichlorethylene, for instance, or if the urinary value is over 10 mg per 100 cc, then corrective measures are considered necessary.

The trichlorethylene in air may be estimated by passing a known volume of vapor through a hot combustion tube containing platinum as a catalyst and then determining the amount of hydrochloric acid formed. A different method used by the Massachusetts Division of Occupational Hygiene is described by Elkins, Hobby and Fuller in the *Journal of Industrial Hygiene & Toxicology*, Vol. 19, No. 9, Nov. 1937, p. 474-485. On the basis of analysis, it is possible to determine whether or not a hazard exists.

Nature of Solvents

In order to design a system for the control of the air contaminant as determined by the methods outlined, it is necessary to know the nature of the contaminant and the method of its use.

For years the solvent used in metal degreasing equipment has been almost exclusively trichlorethylene, although perchlorethylene (tetrachlorethylene) has been used to some extent. Trichlorethylene, like the other chlorinated solvents, is for all practical purposes non-flammable. The chlorine is firmly held by the hydrocarbon. The substance resists decomposition by water and thus is relatively non-corrosive. Stabilizers are added to minimize decomposition from other sources. Because it has a low latent heat of vaporization, the heat input necessary for machine operation is low and relatively large quantities of the vapor are condensed by cool metal parts. The vapor density is 4½ times that of air which gives a tendency to maintain a vapor level inside the tank.

To offset these advantages trichlorethylene, like other chlorinated hydrocarbons, is toxic. Although it is believed to be less toxic than other chlorinated hydrocarbons, most authorities agree that concentrations not exceeding 200 ppm can be tolerated during a working day.

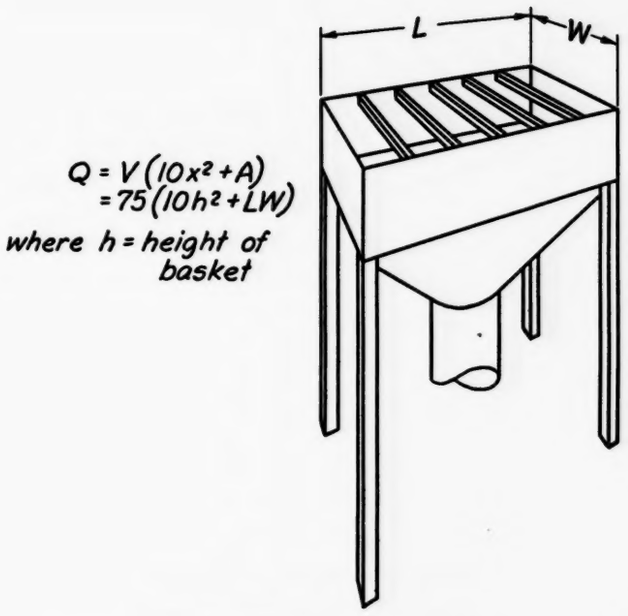


Fig. 2. Local exhaust system.

Metal degreasing may be accomplished in any of four types of systems. The simplest of these involves the immersing of the object in the vapor formed by boiling liquid trichlorethylene. The vapor condenses bcause the object is colder than the vapor, and the clean solvent thus formed on the part dissolves the oil and grease. The dirty solvent drops back into the tank. The other types involve in addition to the vapor treatment, dipping in warm liquid trichlorethylene, and in some cases also in boiling trichlorethylene. Hot solvent is sprayed on the object in some installations to augment the vapor cleaning.

Degreasing equipment designed to prevent the escape of solvent vapors to the working atmosphere is provided by the manufacturer. Cooling coils are located about the sides of the tanks to minimize the tendency of the vapor to rise above a predetermined level. In addition, thermostatic controls are placed in many instances above the cooling coils, so regulated that the heat input is reduced or stopped when the vapor level rises too high. Space above the cooling coils is called the freeboard, and increasing this height adds a factor of safety. This height should never be less than one-half the tank width.

Despite these methods of control, many degreasers are operated improperly either through ignorance or because of production requirements. In other cases, where the operation is practiced carefully, excessive amounts of vapor escape because of the work being handled. In such cases, control may be provided by the installation of ventilation. However, an intelligent appraisal of the process should be made to select a method that will establish adequate control.

Vapor Sources

How and where does the vapor escape? At first analysis, this question may seem ridiculous, but examination will reveal that vapor can escape directly from the degreaser or from liquid adhering to the parts after they have been removed.

There are many reasons why vapors escape directly

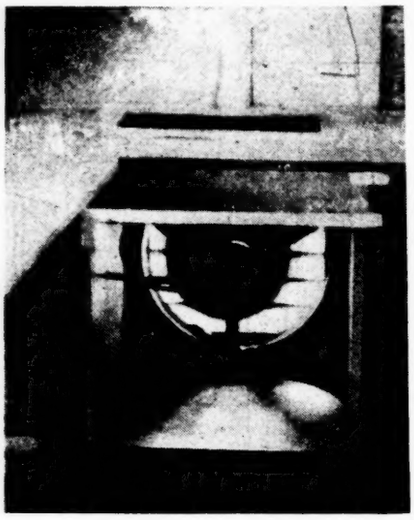


Fig. 3. Grill in workbench.

from the tank. If work is put into the tank in large baskets which almost fill the cross-sectional area, a piston effect is created and visible vapors often escape. In other cases excessively heavy material is introduced, producing an almost instantaneous condensation of the vapor and inducing a flow of air into the partially evacuated tanks. Air thus introduced eddies about the tank and becomes intimately mixed with any remaining vapors. When the vapor level is again raised, the trichlorethylene-laden air is displaced and contamination of the work area ensues.

Where degreasers are overloaded, an escape of fumes results in the sluggish action of control valves. When large heavy parts are introduced into the boiling liquid in the bottom of the tanks cooling occurs and this results in the control valves increasing the heat input. When work is removed from the liquid, the high rate of heat input continues for a short time and vapor is generated rapidly at the time when the heavy hot work is passing through the condensing zone. Because of the increased heat input, and the heat content of the work leaving the degreaser, considerable vapor is lost from the tank.

A rapid introduction of work to the degreaser may also produce such disturbances and it should be avoided through the use of a slow speed hoist. Vapor will escape from a machine if it is located where excessive drafts from circulating fans, unit heaters, ventilators, or open doors or windows will pass over the equipment. In one plant, it was found that concentrations of 170 to 230 ppm vapor existed because of high drafts from adjacent windows, whereas concentrations of 30 to 40 ppm resulted when these drafts were eliminated by baffles. Thus, it is apparent that in the installation of supply air equipment, care must be exercised that high room air velocities are not maintained in the vicinity of degreasers.

Vapor may also escape to the working atmosphere when recessed parts are degreased. This is especially true of small parts degreased in large numbers. Hot liquid condensing in the recessed part is carried out and readily evaporates into the room because of its higher temperature.

How can we control these exposures? Probably the most widely accepted method is the provision of lateral exhaust slots on either of the two long sides of the degreaser. Details of the slot and manifold design are shown in Fig 1. In Massachusetts as in New York, an exhaust rate of 60 cfm per linear foot of tank perimeter is employed.

While such a control method is usually thought to be local exhaust, both that mechanism and dilution of vapor come into play. Hemeon has ascribed most of the control action to dilution. This assumption can be appreciated when it is noted that other authorities recommend varying volumes of air for adequate control. For instance, Brandt recommends 50 cfm per sq ft of tank area, while Morse and Goldberg recommend 30 to 40 cfm per sq ft and Witheridge and Walworth found that 30 cfm per sq ft resulted in adequate control.

Morse and Goldberg found a solvent loss of 4.2 gal per 100 hr per sq ft for non-ventilated tanks and 4.9 for ventilated tanks. If we assume a typical degreaser tank 4 ft long and 3 ft wide, we should have exhaust rates of 840 cfm, 600 cfm and 360 cfm, according to the various authorities (60 cfm per sq ft of tank perimeter, 50 cfm per sq ft and 30 cfm per sq ft). Such a degreaser would lose 0.504 gal per hr or 0.0084 gpm. This would result in 0.05 cu ft of trichlorethylene in the form of vapor. Dividing 0.05 by the various volumes recommended, we should obtain concentrations of 60 ppm, 83 ppm, and 143 ppm, respectively, in the absence of any local exhaust effect.

Examining the method of control from another standpoint, we find that 420 cfm would be exhausted through each of the slots if 60 cfm per ft of perimeter is used. In order to simplify this discussion, let us assume that the slot is a line source of suction in space and the velocity contours are cylinders of revolution. Since the volume of air moving is the product of the velocity and the area, we find that $Q = 420 = AV$. Usually room currents do not exceed 50 fpm, and consequently this value may be considered sufficiently great to induce vapors into the exhaust opening. Therefore, $420 = 50A$ or

$$A = \frac{420}{50} = 8.4$$

The area of a cylinder of revolution is equal to $2\pi rl$. Since the slot is 4 ft long, our equation becomes

$$8\pi r = 8.4 \text{ or } r = \frac{8.4}{8\pi} = .33 \text{ ft or } 4 \text{ in.}$$

Similarly, where 50 cfm per sq ft is recommended, a velocity of 50 fpm would be realized at a distance of about 3 in. from the slot and for 30 cfm per sq ft a velocity of 50 fpm will be obtained no more than 2 in. from the slot.

While this latter consideration of the mechanism of slot ventilation of degreasers is over-simplified, it is apparent that controlling velocities exist only a short distance from the slot. Therefore, it is highly probable that dilution is the important mechanism involved and that the discrepancies among the various authorities are not as serious as they may seem.

In designing a slot-type system for a degreaser, it is important to distribute the air flow as evenly as possible. This can generally be done by maintaining low velocities in the manifold, preferably below 2,000

fpm. In some cases, tapering the manifold is an aid toward better distribution, while in others it is necessary to use vanes or splitters.

While the foregoing method is entirely adequate and is desirable in many cases, difficulty in securing sheet metal demanded substitute methods. One such successful plan involved the installation of a propeller fan in the wall directly behind the degreaser. This may seem to contradict our previous statement regarding the avoidance of drafts, but the following explanation should dispel this idea.

If we consider the propeller fan to be a simple round opening under suction, we find that the velocity contours drop off rapidly as the distance from the fan is increased. The average propeller fan creates an average velocity through its cross section of approximately 1500 fpm. At 1.5 diameters the 3% velocity contour is reached (50 fpm). The same size propeller fan, if turned about, would create a velocity of 50 fpm at about 80 diameters removed. Thus while such a fan can be used to exhaust the vicinity of a degreaser without creating undue drafts, the same fan, if used for circulating purposes, would be undesirable unless removed more than 30 diameters from the degreaser.

A modification of the preceding method was encountered in another plant. This involved the erection of a large booth about the degreaser. Velocities of approximately 30 fpm existed at the working edge, and concentrations of 6 ppm were found to exist. A propeller fan was used to provide the air motion.

While the first method is adequate to control the escape of trichlorethylene from the degreaser itself, it does little toward reducing concentrations occurring because of the dragout of hot liquid. Dragout can be minimized by the proper design of baskets to contain the work. If care is taken to eliminate recesses at the corners and to provide only wire baskets, some dragout will be eliminated.

In the case of small shells which were being degreased, it was found that the stacking of the parts so that openings all pointed down permitted drainage and eliminated considerable dragout. It was also found that better degreasing was obtained.

Vapors thus formed can be removed by a local exhaust arrangement (Fig. 2). This is essentially a grille-top downdraft hood sufficiently large to accommodate the basket being used. The proper air volume to be exhausted can be calculated by means of Dalla Valle's equation:

$Q = V (10X^2 + A)$

Q = volume of air exhausted

V = controlling velocity (generally 75 fpm is sufficient)

X = height of the basket

A = area of the downdraft grille.

It is not uncommon to find instances where control by this latter method alone will reduce the exposure of the worker to a safe limit. We have found such instances in the jewelry trade where chains and small recessed articles are often handled. The size and quantity of these are generally so small that no appreciable load is demanded of the degreaser and thus if proper operation is observed, little escape of vapor occurs from the degreaser itself. However, air contamination from the liquid carried out by the degreased articles is quite likely to be high. A simple but effective control method in such a case was found to be the provision of a grille in a workbench which was completely covered in from the bottom, and the plenum chamber thus formed was exhausted by a propeller fan. A velocity of 550 fpm existed 8 in. above the grille, which was 5 ft removed from the degreaser, Fig. 3.

A similar ventilation arrangement was seen in a plant where metal seats for busses were being degreased. A vapor degreaser approximately 7 ft × 30 in. was located next to a stand formed of two I-beams and metal rungs. A propeller fan with a capacity of 4500 cfm was located 18 in. from the drain stand at floor level. The highest concentration found in this instance was 10 ppm while in three of four samples, the analytical method was not sensitive enough to detect any trichlorethylene.

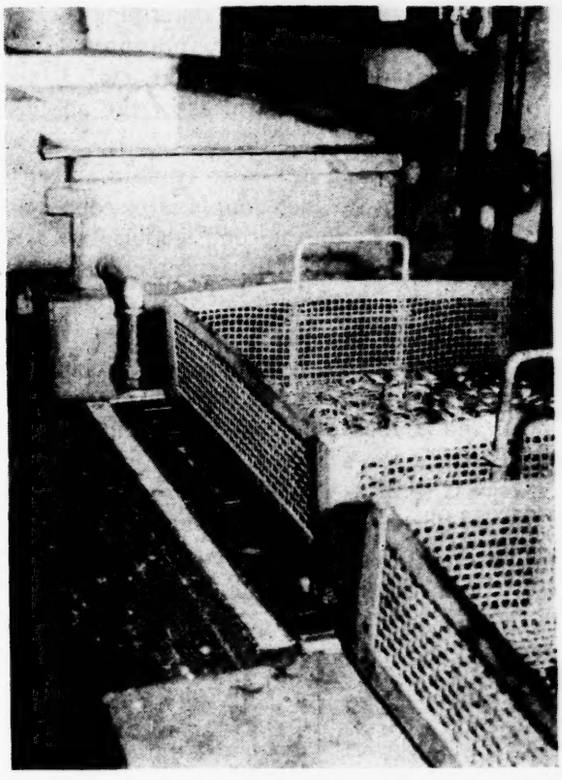


Fig. 4. Parts degreaser.

Occasionally contamination of air occurs from both the material dragged out and from the degreaser itself. In such instances, it is necessary to exhaust the degreaser and provide local exhaust for the degreased parts (Fig. 4). In some installations the downdraft grille is placed immediately adjacent to the degreaser, connecting directly with the plenum chamber of the tank exhaust system.

We believe that, while metal degreasing may present a potential health hazard, there are several acceptable effective methods of control. Care should be taken in determining the sources of vapor escape, in order to design an effective control system.

Quick Solution of Piping Offset and Branch Connection Dimensions

THE accompanying tables, sketches and typical examples are presented to provide an easy-to-use solution of problems involving pipe offsets and branch take-offs of the types illustrated in Figs. 1, 2 and 3, where 125 lb cast iron or 150 lb malleable iron screwed fittings are used. Typical uses of the data are where the offset or distance between lines is known, to determine the length of nipple required; for a given length of nipple, to determine the resulting offset in terms of center to center lines; to determine clearance between fittings, etc.

The following examples will show the application of the data to typical problems.

Example 1. A 3 inch line is to contain a tee, from the side of which a 3 inch nipple is to connect with a 90° ell connected to a second 3 inch line parallel to the first and 17 inches from center line to center line of the two lines. What length nipple will be required?

Solution. From Table 1, find E for 3 inch pipe to be 1 inch. From Table 4, for a 3 inch straight through and 3 inch side outlet tee find $X = 3.08$. From Table 5, for a 3 × 3 inch ell find $Y = 3.08$. Then $L = C + 2E - X - Y$ or $L = 17 + (2 \times 1) - 3.08 - 3.08 = 12.84$ inches, length of nipple.

Example 2. A 1¼ inch line is reduced at a tee to 1 inch. From the ¾ inch side outlet a length of ¾ inch pipe is to connect to a ½ inch line by a 90° reducing ell, with the two lines 12½ inches center to center. What length nipple is required?

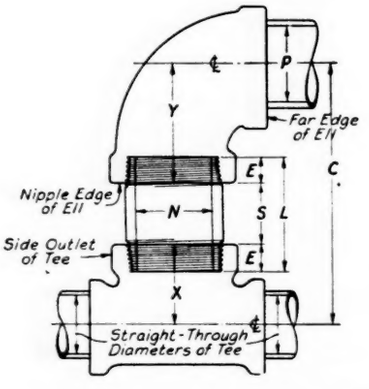
Solution. From Table 1, find E for a ¾ inch thread to be 9/16 inches (0.56). In the 1¼ × 1¾ tee, 1¼ is the larger of the straight through diameters. Opposite 1¼ in the left column of Table 4, find the diameter of the side outlet (¾) opposite which find $X = 1.62$. In the left column of Table 5 find the nipple diameter of the ell (¾) opposite which locate the far diameter of the nipple (½) opposite which find $Y = 1.20$. Then $L = C + 2E - X - Y$ or $L = 12.5 + 2\ (0.56) - 1.62 - 1.20$ or $L = 10.8$ inches, length of nipple.

Example 3. In example 2, how close could the two parallel lines have been run, center to center, if a close nipple had been used?

Solution. For a ¾ inch close nipple, $L = 1\frac{3}{8}$, from Table 2. Then $C = L + X + Y - 2E$ or $C = 1.38 + 1.62 + 1.20 - 2\ (0.56) = 3.08$ inches, center to center.

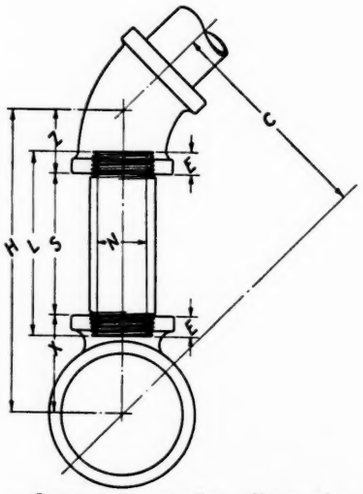
Example 4. A 2 inch branch is to be taken from a 3 inch main through a nipple and 45° ell as shown in Fig. 2. If the center to center distance is 20½ inches, what length of 2 inch nipple is required?

(Continued in tables on next page and text concluded on page 79.)



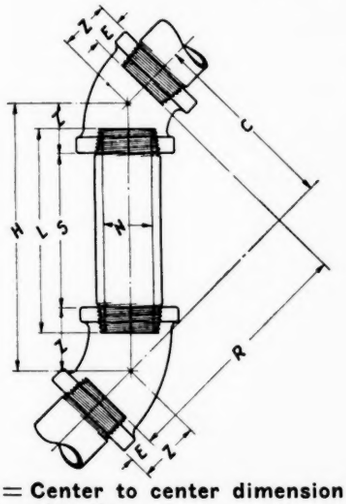
C = Center to center dimension of pipe lines
L = Length of nipple = C + 2E — X — Y
X = Distance from center line of tee to edge of side outlet
Y = Distance from center line of line at far edge of ell to nipple edge of ell
N = Diameter of nipple
E = Engagement of nipple thread
P = Diameter of line at far edge of ell
S = Distance between fittings (= L — 2E)

Fig. 1. Take-off through tee and 90° ell.



C = Center to center dimension of pipe lines
L = Length of nipple = 1.41C + 2E — X — Z
X = Distance from center line of tee to edge of side outlet
Z = Distance from center of 45° ell to edge of ell
N = Distance of nipple
E = Engagement of nipple thread
S = Distance between fittings (= L — 2E)
H = Distance from center line of tee to center of ell

Fig. 2. Take-off through tee and 45° ell.



C = Center to center dimension of pipe lines
L = Length of nipple = 1.41C — B
H = Distance between centers of ells = 1.41C for 45° ells
N = Diameter of nipple
E = Engagement of nipple thread
Z = Distance from center to edge of 45° ell
S = Distance between fittings
B = 2Z — 2E. Values given in Table 3 = R-C
R = Distance along pipe axis from end of main to end of branch = C + B

Fig. 3. Take-off or offset through two 45° ells.

TABLE 1. — NORMAL ENGAGEMENT TO MAKE TIGHT JOINTS

Pipe Diameter, Inches	Engagement, E, Inches
½	½
¾	9/16
1	11/16
1¼	11/16
1½	11/16
2	¾
2½	15/16
3	1
3½	1 1/16
4	1⅛
4½	1 3/16
5	1¼
6	1 5/16
7	1⅜
8	1 7/16
9	1½
10	1⅝
12	1¾

TABLE 2.—LENGTH OF STANDARD CLOSE AND SHORT NIPPLES

Pipe Diameter, Inches	Overall Length, Inches	
	Close	Short
½	1⅛	1½
¾	1⅜	2
1	1½	2
1¼	1⅝	2½
1½	1¾	2½
2	2	2½
2½	2½	3
3	2⅝	3
3½	2¾	4
4	2⅞	4
4½	2⅞	4
5	3	4½
6	3⅛	4½
7	3¼	5
8	3½	5
9	3⅝	5
10	3⅞	5
12	4½	6

TABLE 3.—VALUES OF Z AND B FOR 45° ELLS

Dia. of Elbow, Inches	Z, Inches	B, Inches
½	0.88	.76
¾	0.98	.83
1	1.12	.86
1¼	1.29	1.20
1½	1.43	1.48
2	1.68	1.86
2½	1.95	2.02
3	2.17	2.34
3½	2.39	2.65
4	2.61	2.97
5	3.05	3.60
6	3.46	4.29
8	4.28	5.68
10	5.16	7.07
12	5.97	8.44

TABLE 4.—VALUES OF X FOR STRAIGHT AND REDUCING TEES

Larger of the Straight-Through Diameters of Tee, In.	Tee Side Outlet Diameter, In. (N)	X, In.	Larger of the Straight-Through Diameters of Tee, In.	Tee Side Outlet Diameter, In. (N)	X, In.	Larger of the Straight-Through Diameters of Tee, In.	Tee Side Outlet Diameter, In. (N)	X, In.
½	⅜	1.03	2	1½	2.16	4	3½	3.69
½	½	1.12	2	2	2.25	4	4	3.79
½	¾	1.20	2	2½	2.39	4	5	4.00
¾	⅜	1.13	2	3	2.52	4	6	4.13
¾	½	1.22	2½	½	2.23	5	1½	3.94
¾	¾	1.31	2½	¾	2.32	5	2	4.03
¾	1	1.45	2½	1	2.37	5	2½	4.13
1	⅜	1.27	2½	1¼	2.45	5	3	4.22
1	½	1.36	2½	1½	2.51	5	3½	4.31
1	¾	1.45	2½	2	2.60	5	4	4.41
1	1	1.50	2½	2½	2.70	5	5	4.50
1	1¼	1.65	2½	3	2.83	5	6	4.63
1	1½	1.90	2½	4	3.05	6	2	4.56
1¼	½	1.53	3	¾	2.61	6	2½	4.66
1¼	¾	1.62	3	1	2.66	6	3	4.75
1¼	1	1.67	3	1¼	2.74	6	4	4.94
1¼	1¼	1.75	3	1½	2.80	6	5	5.03
1¼	1½	1.82	3	2	2.89	6	6	5.13
1½	½	1.66	3	2½	2.99	6	8	5.56
1½	¾	1.75	3	3	3.08	8	2	5.84
1½	1	1.80	3	3½	3.18	8	2½	6.01
1½	1¼	1.88	3	4	3.30	8	3	6.07
1½	1½	1.94	3½	3½	3.42	8	4	6.17
1½	2	2.02	4	1	3.18	8	5	6.27
2	½	1.88	4	1¼	3.26	8	6	6.37
2	¾	1.97	4	1½	3.32	8	8	6.56
2	1	2.02	4	2	3.41	10	10	8.08
2	1¼	2.10	4	2½	3.51	12	12	9.50

TABLE 5.—VALUES OF Y FOR STRAIGHT AND REDUCING 90° ELLS

Dia. of Ell at Nipple (N) End, In.	Dia. of Ell at Line End (P), In.	Y, In.	Dia. of Ell at Nipple (N) End, In.	Dia. of Ell at Line End (P), In.	Y, In.	Dia. of Ell at Nipple (N) End, In.	Dia. of Ell at Line End (P), In.	Y, In.
½	½	1.12	1½	¾	1.52	3	2½	2.83
½	¾	1.22	1½	1	1.65	3	3	3.08
½	1	1.36	1½	1¼	1.82	3	4	3.60
¾	½	1.20	1½	1½	1.94	3½	3½	3.42
¾	¾	1.31	1½	2	2.16	4	2	2.74
¾	1	1.45	1½	2½	2.51	4	3	3.30
¾	1¼	1.62	2	¾	1.60	4	4	3.79
¾	1½	1.75	2	1	1.73	4	5	4.41
¾	2	1.97	2	1¼	1.90	4	6	4.94
1	½	1.26	2	1½	2.02	5	4	4.00
1	¾	1.37	2	2	2.25	5	5	4.50
1	1	1.50	2	2½	2.60	5	6	5.03
1	1¼	1.67	2	3	2.89	6	4	4.13
1	1½	1.80	2	4	3.41	6	5	4.63
1	2	2.02	2½	1½	2.16	6	6	5.13
1¼	¾	1.45	2½	2	2.39	6	8	6.37
1¼	1	1.58	2½	2½	2.70	8	6	5.56
1¼	1¼	1.75	2½	3	2.99	8	8	6.56
1¼	1½	1.88	3	2	2.52	10	10	8.08
1¼	2	2.10				12	12	9.50

Greenhouse Heating Calculations

The special problems of greenhouse heating arising out of large glass area, low air temperature, and high radiator emission are simplified by tables based on Department of Agriculture data.

THE heating of greenhouses often involves somewhat low air temperatures at which the heat emission of radiators is increased over that at the conventional 70F air temperature. In addition, these buildings have an extraordinarily large glass area, so that calculations can frequently be simplified by use of tables based on glass area only, with allowance for infiltration and the relatively small wall surface. Such tables are included here; with the exception of Table 3, they are based on data by Arthur H. Senner of the Department of Agriculture, although they have been somewhat rearranged.

Usual greenhouse inside air temperatures are given in Table 1, and these data are suggested for use where the grower has not specified other temperatures due to variations in his own methods from standard practice.

In calculating heat losses from greenhouses, it is possible, due to the low ratio of losses through infiltration and walls to that through glass, simply to add an allowance for air leakage and wall loss and base the whole calculation on glass area. This is done in Table 4.

TABLE 2.—HEAT EMISSION FROM 1000 LINEAR FEET OF PIPE RADIATION

(Based on 220F steam, 160F gravity hot water, and 210F forced hot water)

Pipe Dia., In.	Heating Medium	Greenhouse Temperature, F						
		40	45	50	55	60	65	70
		Btu per Hr per 1000 Linear Feet of Pipe						
1¼	Low pressure steam	187,400	180,300	173,300	166,300	160,000	153,300	147,000
2	Gravity hot water	150,200	143,500	135,300	127,700	121,000	113,700	106,800
2	Forced hot water	236,700	227,500	217,500	207,700	199,500	190,800	182,500
3½	Gravity hot water	245,000	232,300	219,700	204,000	193,000	181,800	169,800

TABLE 3.—CAST IRON RADIATOR SURFACE REQUIRED PER 1000 BTU PER HOUR

(Based on 220F steam, 160F gravity hot water, and 210F forced hot water)

Heating Medium	Greenhouse Temperature, F						
	40	45	50	55	60	65	70
	Sq Ft of Radiator per 1000 Btu Output per Hr						
Low pressure steam	3.06	3.20	3.38	3.50	3.64	3.82	4.00
Gravity hot water	5.37	6.68	6.00	6.32	6.70	7.14	7.62
Forced hot water	3.38	3.50	3.64	3.82	4.00	4.19	4.36

TABLE 1.—CUSTOMARY TEMPERATURES FOR GREENHOUSES

Type of Plant	Temperature Range, F
Carnation	45-55
Conservatory (general collection, winter, garden, etc.)	60-65
Cool	45-50
Cucumber	65-70
Fern	60-65
Forcing	60-65
General purpose	55-60
Lettuce	40-45
Orchid, warm	65-70
Orchid, cool	50-55
Palm, warm	60-65
Palm, cool	50-55
Propagating	55-60
Rose	55-60
Sweet pea	45-50
Tomato	65-70
Tropical	65-70
Violet	40-45

TABLE 4.—HEAT REQUIRED TO MAINTAIN GREENHOUSE TEMPERATURE PER 1000 SQ FT OF GLASS AREA

(Including both heat transmission through glass and allowance for infiltration)

Inside Temperature, F	Outside Temperature, F					
	20	10	0	—10	—20	—30
	Btu Required per Hr per 1000 Sq Ft of Glass					
40	28,600	41,000	53,800	66,800	79,200	92,200
45	34,800	47,500	60,100	72,600	85,300	98,000
50	41,250	53,800	66,450	79,000	91,700	104,500
55	47,500	60,500	72,800	85,300	98,500	111,000
60	53,700	66,600	79,100	91,700	104,500	117,300
65	59,700	72,600	85,400	98,300	111,000	123,000
70	66,250	79,200	91,700	104,800	117,500	129,500

TABLE 5.—AREA OF GLASS HEATED PER LINEAR FOOT OF 1¼ STEAM PIPE
(Based on 220F Steam)

Inside Temp., F	Outside Temperature, F					
	20	10	0	—10	—20	—30
	Area of Glass, Sq Ft					
40	7.57	5.27	4.01	3.23	2.73	2.35
45	5.92	4.34	3.43	2.84	2.42	2.11
50	4.83	3.70	3.00	2.52	2.18	1.91
55	4.08	3.18	2.65	2.27	1.97	1.75
60	3.46	2.79	2.35	2.03	1.78	1.59
65	2.98	2.46	2.09	1.82	1.61	1.45
70	2.54	2.13	1.83	1.61	1.43	1.30

TABLE 6.—AREA OF GLASS HEATED PER LINEAR FOOT OF 2 INCH GRAVITY HOT WATER PIPE
(Based on 160F water)

Inside Temp., F	Outside Temperature, F					
	20	10	0	—10	—20	—30
	Area of Glass, Sq Ft					
40	5.28	3.68	2.80	2.26	1.91	1.64
45	4.13	3.03	2.39	1.98	1.69	1.47
50	3.29	2.52	2.04	1.72	1.48	1.30
55	2.72	2.12	1.76	1.51	1.31	1.16
60	2.24	1.82	1.53	1.32	1.16	1.03
65	1.89	1.56	1.33	1.15	1.02	.92
70	1.63	1.36	1.17	1.03	.91	.83

Determine the wall area and assume 2, 3, or 4 sq ft of wall (depending on construction) as equal to 1 sq ft of glass and use Table 4 in which allowance has already been made for infiltration. The figures in the body of Table 4 can also be used to determine pounds of steam required if three digits are crossed off.

Once the load has been calculated, the length of pipe required in the coils, or amount of radiator surface needed, can be found by reference to Table 2 or 3. However, it is probably more convenient to work directly from the equivalent glass area tables —Tables 5 to 8, inclusive.

In sizing steam mains, use can be made of Heating and Ventilating *Reference Data 299-300.* For gravity hot water, Table 9 gives sizing data for supply and return mains.

TABLE 7.—AREA OF GLASS HEATED PER LINEAR FOOT OF 3½ INCH GRAVITY HOT WATER PIPE
(Based on 160F water)

Inside Temp., F	Outside Temperature, F					
	20	10	0	—10	—20	—30
	Area of Glass, Sq Ft					
40	8.60	5.97	4.56	3.68	3.10	2.67
45	6.66	4.88	3.87	3.20	2.73	2.37
50	5.33	4.08	3.31	2.78	2.39	2.11
55	4.32	3.38	2.81	2.41	2.08	1.85
60	3.60	2.92	2.45	2.12	1.85	1.65
65	3.00	2.48	2.10	1.82	1.62	1.46
70	2.56	2.14	1.84	1.62	1.44	1.31

TABLE 8.—AREA OF GLASS HEATED PER LINEAR FOOT OF 2 INCH FORCED HOT WATER PIPE
(Based on 210F water)

Inside Temp., F	Outside Temperature, F					
	20	10	0	—10	—20	—30
	Area of Glass, Sq Ft					
40	8.34	5.80	4.42	3.57	3.00	2.58
45	6.54	4.78	3.79	3.13	2.67	2.33
50	5.28	4.05	3.28	2.77	2.38	2.09
55	4.40	3.43	2.86	2.45	2.12	1.88
60	3.70	2.98	2.52	2.17	1.91	1.70
65	3.20	2.64	2.24	1.95	1.73	1.55
70	2.77	2.32	1.99	1.75	1.55	1.41

TABLE 9.—SIZE OF MAINS FOR GRAVITY HOT WATER PIPE COILS
(Based on 160F water, and a total length of supply and return mains of not over 200 ft.)

Size of Supply and Return, In.	Diameter of Pipe in Coil, Inches	
	3½	2
	Linear Feet of Pipe in Coil	
1¼	50	80
1½	80	140
2	190	320
2½	380	650
3	660	1,100
3½	1,000	1,700
4	1,500	2,600
5	3,000	5,000
6	5,200	8,700

Quick Solution of Piping Offset

(Concluded from page 77.)

Solution. From Table 1, the thread engagement E for 2 inch pipe is ¾ inch. From Table 4, a 3 × 3 × 2 tee has a dimension X of 2.89 inches. From Table 3, Z for a 2 inch 45° ell is given as 1.68 inches. Then L = 1.41C + 2E — X — Z or L = (1.41 × 20.5) + 2 (¾) — 2.89 — 1.68 or L = 25.8 inches.

Example 5. A 1 inch line is to be offset 7¼ inches using two 45° ells as shown in Fig. 3. What length nipple is required and what will the gap between pipe ends (R) be?

Solution. The value of 1.41C is 1.41 × 7.25 or 10.22 inches. From Table 3, the value of B for ¾ inch pipe is .83 inch. Since L = 1.41C — B, then L = 10.22 — .83 or 9.39 inches. Since R = C + B, we have R = 7.25 + .83 = 8.08 inches.

Air Conditioned Buses

Air conditioning, ventilating and heating features of two types of buses now being produced.

TWO types of air conditioned buses of post-war design are now being produced by the ACF-Brill Motors Co., Philadelphia, Pa. Both models, one for city service, and the other for intercity trips, incorporate features of interest to the air conditioning engineer.

The city coach, C-36, which is the first air conditioned city bus ever built, seats 36 passengers and the intercity model, IC-41, is designed for 37 or 41 passengers. Essentially, the air conditioning system, which has been designed and is being manufactured by Carrier, is the same for both models. The complete air conditioning unit weighs from 650-700 lb.

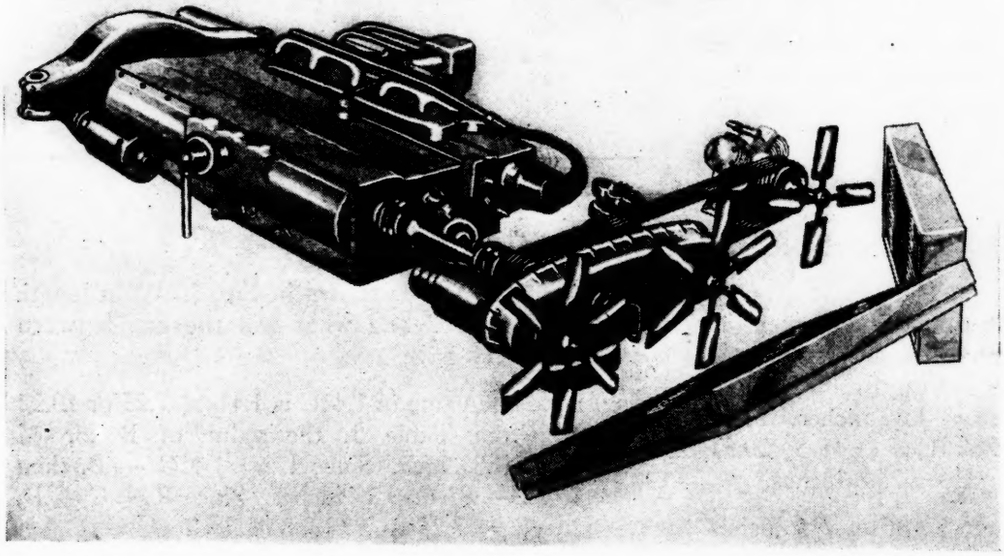
Air conditioned bus designed for service between cities.

In designing the system, outside air was assumed to be at 100F dry bulb and 80F wet bulb, and inside conditions of 83F dry bulb and 70F wet bulb. For the 36-passenger bus with full occupancy, an analysis of the heat load follows:

	Btu per hr	Approximate % of total load
Ventilation air 360 cfm	14,690	30
36 people	14,410	30
Sunlight	6,240	13
Roof transmission heat	3,360	7
Floor transmission heat	3,100	6
Glass transmission heat	2,880	6
Wall transmission heat	1,620	3
Infiltration of air	2,040	4
Fan motor heat	625	1
	48,965	100

This analysis of the heat load assumes that all walls are exposed to the sun, that single glass windows are used, that shades are provided to keep out direct sunlight. Also that the roof and sides of the bus are insulated with the equivalent of 1½ in. of mineral felt, nc insulation for the floor, and outside air taken in for ventilation to be about 10 cfm per person. However, there is a ⅜ in. layer of cork cemented to the plywood floor in the IC-41. Insulation selected is Johns-Manville type M stone felt, 1½ in. thick.

The air conditioning system has an average cooling capacity of 4 tons although the actual output may vary from this figure. The compressor, Carrier type 5-F-20, has two cylinders, 2½ in. bore and 2 in. stroke with a capacity of 19.63 cu. in. displacement per revolution. As the compressor is operated from an accessory drive from the main power plant, it is not possible to control the speed of the com-



Power plant and separate drive for accessories. Two-cylinder air conditioning compressor is shown at right. This is the arrangement for the intercity bus.

pressor. Allowing for the belt drive ratio, the compressor must operate at a speed corresponding to the main propulsion engine.

For the IC-41, the compressor is driven by 3 V belts with a pulley ratio of 1 to 1. For the other, the compressor is driven by similar belts but the pulley ratio of compressor to engine is 8 to 7.

Had an independent gas engine been employed for the compressor drive, there would have been an increase in cost and overall weight. However, it would have been possible to run the cooling unit without operating the power plant, but only for short periods due to lack of sufficient engine cooling without the main engine fan. Eliminating a special engine for the compressor avoids the added service and repairs for the small driving unit.

For the city model, the evaporator is mounted at the rear of the coach over the 5-passenger settee. Ducts which run back of the card rack carry the fresh air that is taken in at the front to the evaporator. The IC-41 has the evaporator mounted at the front end of the bus up under the ceiling. In both models, cooled air from the evaporator is delivered through a perforated center ceiling panel, and also through openings at the edges of the panel to facilitate air flow in the area adjacent to windows.

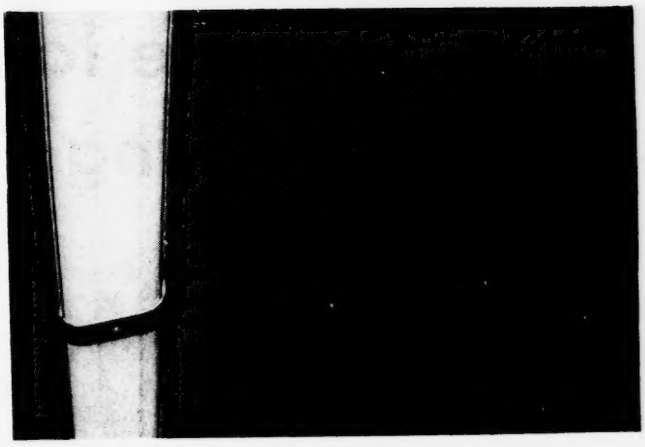
For proper absorption of heat into the cooling coil about 1,250 cfm of air must be circulated over the coil. This same amount of air must be circulated through the bus to absorb the heat load of the bus and its occupants. The air is made up of a mixture of 1/3 outside air and 2/3 recirculated air.

It is also interesting to note that due to heat reflection from the road, air entering the condenser coil often times reaches a temperature of 110F or higher. To remove the heat and condense the refrigerant gas, about 2,500 cfm of air must be circulated through the condensing coil.

The system has been designed to maintain a differential of 15F between outside and inside temperatures. Because of variations in humidity, the actual differential may be different. If the humidity is extremely high, a 10F differential is about all that can be attained.

The bus operator has no control over the cooling system other than the ability to turn it on or off. Once turned on, the air conditioning controls function automatically. As safety measures for the high pressure side of the system, a solenoid valve is set to close the liquid line when the head pressure reaches 260 lb. As a final safety measure, should all other safety devices fail, a rupture diaphragm connected to the receiver is set to blow at 300 lb.

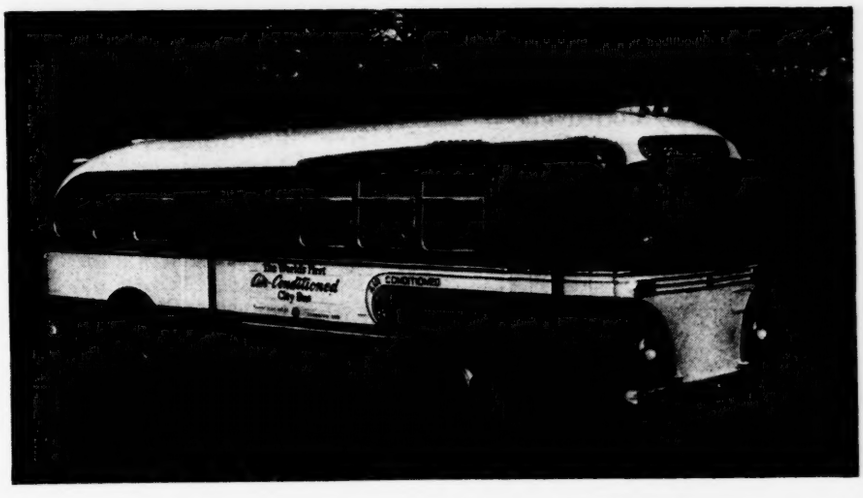
The buses are heated by circulating hot water from the main engine cooling system. Hot water is passed through the heater units and the heated air is distributed through the bus by means of ducts. In both models, the heating system provides 62,000 Btu per hour based on a water temperature of 170F. Air which flows through the heaters is 100% recirculating.



Perforated center ceiling section through which the cooled air is circulated from the evaporator.

The intercity bus is provided with forced draft ventilation, and this system is optional for the city coach. Air enters through grilles on the roof over the windshield, is filtered, and is then blown to the center ceiling duct which extends the full length of the coach. Fresh air is distributed through the same perforated ceiling panel used when cooled air is circulated. The ventilating fan, which is controlled by the driver, delivers 1200 cfm. In other words, independently of the bus speed, there is a complete air change every three minutes.

While at the present time there are many air conditioned intercity coaches in service, the city bus recently built by ACF-Brill, the first of 100 for the San Antonio Transit Co., is the first air conditioned urban coach ever built. Tests have now proved that the air conditioning of city buses is wholly practical, the bus having been operated in scheduled service on five lines in San Antonio over a two-week period in December. It is generally believed that the public demand will dictate a greater adoption of this type of conveyance.



The first air conditioned city bus for urban service.

Length of Pipe for Radiant Heating Coils

For quick determination of the actual length of pipe in a sinuous coil radiant heating panel, the following method has been worked out. It will be useful in cost and weight estimation.

WHEN the area and tube spacing of a heated floor, wall, or ceiling panel for radiant heating have been calculated, it may be necessary, in connection with cost estimating, to determine the length of pipe in the coil. The accompanying formulas will assist in the solution of this problem.

The data which follow assume: (1) inlet and outlet ends of a length equal to a quarter circle as shown in Fig. 1 and that the area of the heated panel extends beyond the coil area in all directions a distance equal to half the pipe or tube spacing, as shown in Fig. 1.

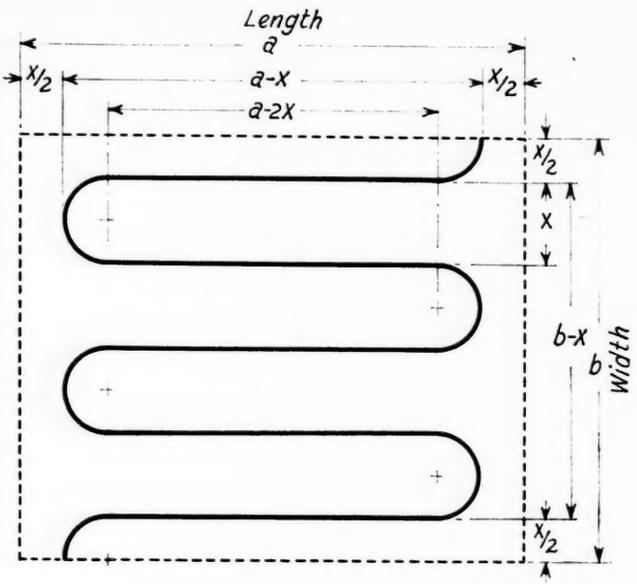


Fig. 1. Coil with inlet and outlet at diagonally opposite ends.

Referring to Fig. 1,

x = the tube or pipe spacing, center to center of pipe, feet;
A = area of heated panel, sq ft (that area enclosed by dotted line in Fig. 1);
a = length of panel, ft;
b = width of panel, ft;
L = length of pipe required for coil, ft.

To maintain the conditions shown in Fig. 1, it is seen that $\frac{b}{x}$ must be a whole number; if $\frac{b}{x}$ is an odd number, the number of passes or runs will be odd, and the inlet and outlet will be at diagonally opposite ends; if $\frac{b}{x}$ is even, the number of passes is even and the inlet and outlet will be at the same end. The problem, then, should be entered knowing from previous calculations, the area A, spacing x, and relative positions of inlet and outlet.

The length of the coil is

$$L = \frac{A}{x} - .43b$$

Example. Calculations show a required panel area of 228 sq ft, a pipe spacing of 9 inches, and it is desirable to have the inlet and outlet at opposite ends. The panel width b must be between 13 and 16 feet, due to space limitations. What are the length and other coil dimensions?

Solution. Assume $b = 15$ ft. Since $x = \frac{9}{12} = .75$ ft, then $b/x = 15/.75 = 20$, an even number. So that the inlet and outlet will be at opposite ends, assume $b/x = 21$, an odd number, and b will be 15.75 ft. Using equation (2)

$$L = \frac{228}{.75} - (.43 \times 15.75) = 297.23 \text{ ft.}$$

The length (center line to center line) of the finished coil $(a—x) = \frac{228}{15.75} - .75 = 13.73$ ft. The width (center line to center line) of the finished coil, exclusive of curved inlet and outlet, or $b - x = 15.75 - .75 = 15$ ft. The distance between centers of coil radii, $a - 2x = 14.48 - 1.50 = 12.98$ ft.

Other useful variations of the equation for L are

$$L = A\left(\frac{1}{x} - \frac{.43}{a}\right)$$

$$L = \frac{ab}{x} - .43b$$

An Omission—Due to an oversight, the sources of two drawings were omitted from John W. Markert's article on selecting centrifugal and axial flow fans in the December issue of HEATING AND VENTILATING. These were Fig. 5, reproduced through the courtesy of the Buffalo Forge Co., and Fig. 6, by permission of La Del Conveyor & Mfg. Co.

Selecting Centrifugal Pumps

PHILIP J. OLMSTEAD
Design Engineer, Goulds Pumps, Inc.

Because centrifugal pumps are used so extensively in industry for the transportation of fluids, it is the intention of this article to outline the important factors of centrifugal pump operation and the data required for the proper selection of centrifugal pumps. In many process industries, pumps are their very heart and pulse. Many times pumps on certain industrial applications are so important and so critical that if the pump should stop fluid delivery, the process cycle would be idle. This article looks into facts concerning the centrifugal pump and its operating characteristics. Many illustrative problems are presented.

CENTRIFUGAL pump development is of comparatively recent origin, and for that reason many regard the unit as a mysterious device to pump liquids.

Actually the first centrifugal pump was built around 1680, but in the United States it was not until 1818 that the first practical pump of this type was constructed. Reynolds developed the turbine type centrifugal pump in England in 1887. Since centrifugal pumps are essentially high speed machines, it was not until the advent of high speed electric motors and steam turbines in the early twentieth century that centrifugal pumps came into popular use.

There are two distinct types of centrifugal pumps, the turbine type pump which uses diffusers or guide vanes in the casing for the conversion of the velocity to pressure energy, and the volute type centrifugal pump. Since the volute type centrifugal pump is most commonly used, this article will deal only with volute type characteristics.

Pressure Head

Mechanically, a volute type centrifugal pump is a simple machine—a velocity machine akin to centrifugal blowers and compressors, and steam and gas turbines. Essentially it consists of an impeller or runner having curved vanes revolving on a shaft and housed in a shell or casing. Liquid enters the impeller axially to the shaft and it has energy imparted to it by rotating vanes of the impeller. The fluid leaves the periphery of the impeller at a relatively high velocity and is collected in the casing or shell. This casing is so designed that the velocity of the liquid is gradually reduced before it is discharged. Here the velocity of the liquid is converted into pressure by reduction of velocity according to Bernoulli's theorem.

The amount of liquid discharged by the pump is almost always measured in gallons per minute although sometimes the measure is cubic feet per second. In this article we shall use the measure of gallons per minute in discussing the capacity or discharge of pumps.

Pressure developed by a centrifugal pump is always specified as head in feet of liquid. Use of this nomenclature may be traced to the basic hydraulic formula,

$$V^2 = 2gh \text{ or } h = \frac{V^2}{2g},$$

where h = head in feet, V = velocity in feet per second and g = the acceleration of gravity (32.2 feet per second per second). In order to convert pressure in pounds per square inch (P) into head in feet of liquid (h), the following formula is applied:

$$h = \frac{P \times 2.31}{\text{specific gravity of the liquid compared to water (water 60/60° = 1.00)}}$$

The head developed by a centrifugal pump is a function of the impeller diameter and the speed of rotation (rpm). The maximum head that can be developed by a centrifugal pump is when the discharge valve is tightly closed and the pump is discharging zero capacity into the system. This is known as the "shut-off" head of the pump. Since there is a predetermined maximum pressure that the pump can develop and this pressure is taken into account by the designer, centrifugal pumps do not require relief valves or other unloading mechanisms that are otherwise necessary for the positive displacement type of pumps. The maximum or "shut-off" head h_s of any centrifugal pump can be very closely calculated by the formula:

$$h_s = \left(\frac{D \times N}{1840}\right)^2$$

where D = outside diameter of the impeller in inches. N = rpm.

OPERATING CHARACTERISTICS

Hydraulic operating characteristics of all centrifugal pumps, or performance curve is shown graphically in Fig. 1. The pressure or head in feet of liquid developed by the pump at a specified impeller diameter and at a constant rpm is plotted against the discharge of the pump in gallons per minute (gpm). The discharge in gpm is the abscissas with head in feet as the ordinate. Included on the performance curve are the efficiency and

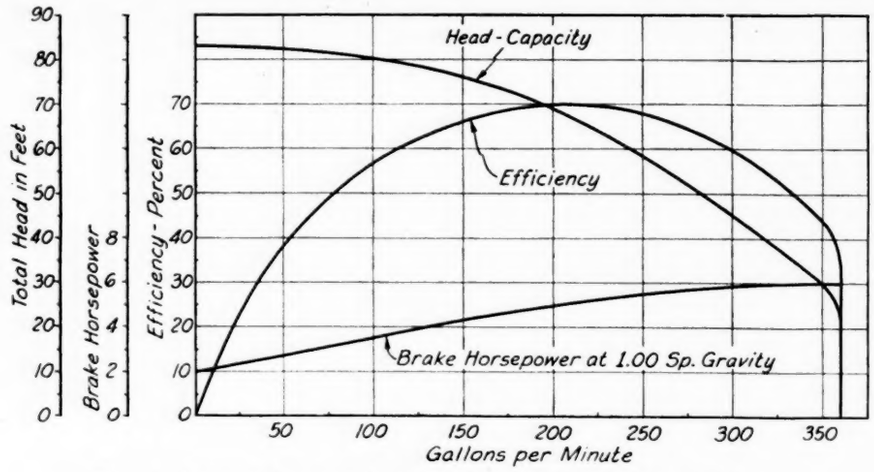


Fig. 1. Curves for constant speed of 1,750 rpm and 9.5 in. impeller diameter.

brake horsepower curves plotted against the discharge in gpm. From this pump performance curve we can readily see some important facts concerning centrifugal pump operation. Note that the maximum head developed by the pump is at zero capacity or shut-off as previously mentioned.

Head Capacity

The head-capacity curve is a sloping line from shut-off to maximum or wide-open capacity. In other words, as the pump discharges more liquid, its pressure decreases. The reason for the slope in the head-capacity curve is due to two things. 1. The curve or shape and the number of vanes in the impeller; 2. Friction or head loss within the pump. As the pump discharges more liquid, there is increased internal friction, and this friction loss is actually a loss in pressure or head at the discharge of the pump—hence, the slope in head-capacity curve. The designer can control to a certain degree the slope of the head-capacity curve by the shape or warp of the impeller vanes and also the number of vanes. The internal friction, however, is a factor over which the designer has very little control.

Efficiency Curve

The efficiency curve rises to a peak within certain capacity limits and then falls off toward the maximum capacity of the pump. The brake horsepower curve is usually as shown, that is, it gradually increases in value as the capacity increases. Maximum efficiency of a centrifugal pump lies within the design range. The designer in laying out the pump had a definite capacity and head upon which all his calculations were based, and his calculations were such that the maximum efficiency of the pump would be at or very near his design capacity.

The performance curve, Fig. 1, was stated to be at a specified impeller diameter and at a constant speed. One of the great advantages of a centrifugal pump over the positive displacement type of pump is its flexibility of operation. This flexibility lies in the fact that the centrifugal pump manufacturer does not have to physically alter his design for every rating within the capabilities of one size of pump, except to the extent of trimming or reducing the outside diameter of the pump impeller. Therefore, with one set of patterns and castings for one size of pump without alterations, except for machining the impeller, the manufacturer can meet any one combination of head and capacity ratings within the operating range or limitation of the pump. The manufacturer, in his testing laboratory, runs complete performance tests on one pump size at a constant speed and at various impeller diameters.

Performance Example

An example of the composite results of his tests are shown in Fig. 2. These composite performance curves readily show the effect upon the head-capacity curve brought about by the change in the impeller diameter and also give a complete story as to the operating range or limitation of the pump at that particular constant speed. It may be well to explain how this composite performance curve is interpreted. Let us assume we require a capacity of 225 gpm at 70 ft total dynamic head. From the capacity curve we read 225 gallons per minute upwards until we intersect the line of 70 ft total dynamic head as shown by the dash lines. We see that the pump has an efficiency at this rating of 70% and falls within the horsepower range of a 7½ hp motor. This particular pump would require an impeller of 9½ in. dia. for the stated rating. This particular pump could also be applied for a rating of 275 gpm against a total dynamic head of 50 ft requiring the use of a 9 in. dia. impeller and a 7½ hp electric motor, the pump efficiency being 62% at this rating.

The efficiency of a centrifugal pump, as for any machine, is the horsepower output divided by the horsepower input. The pump manufacturer in running tests for his composite rating curves, Fig. 2, measures the horsepower input to the pump at various capacities at various impeller diameters all at a constant speed of rotation. The horsepower input is measured on some type of dynamometer or by use of a calibrated electric motor. The horsepower output (HP_o) or water horsepower of the pump is calculated as follows for a definite capacity in gpm:

$$HP_o = \frac{\text{gpm} \times \text{total dynamic head in ft} \times 8.33}{33{,}000}$$

The gpm discharge multiplied by 8.33 (the weight in pounds of one gallon of water) gives us the total weight in pounds being discharged by the

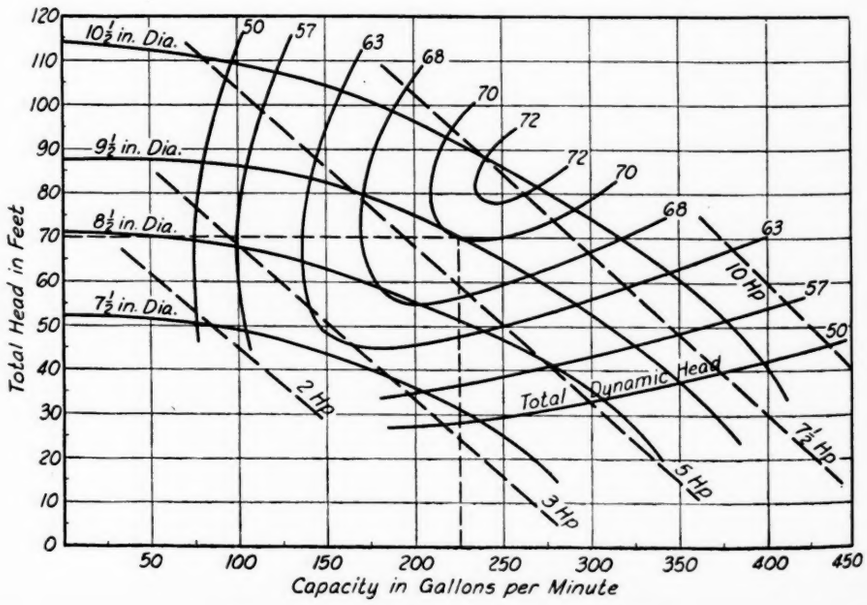


Fig. 2. For constant speed of 1,750 rpm

pump each minute. This value multiplied by the total dynamic head in feet gives us the total of foot-pounds per minute. Since 33,000 foot-pounds per minute equals one horsepower, we divide our total foot-pounds per minute by 33,000 to determine our horsepower output. When the efficiency is known or pre-calculated as in the case of the composite curve, Fig. 2, we can determine the horsepower requirement of the pump by the formula:

$$HP = \frac{\text{gpm} \times \text{total dynamic head in ft}}{3960 \times \text{eff. (expressed as a decimal)}} \times \text{specific gravity}$$

This formula holds for any liquid since the specific gravity of the liquid as compared with water is inserted in the formula.

For example: if the pump is pumping water and is discharging a certain quantity of water at a certain total dynamic head requiring a definite horsepower, this same pump handling a liquid lighter than water such as gasoline (.75 specific gravity) or, a liquid heavier than water, such as calcium chloride brine (1.2 specific gravity), would discharge the same quantity of liquid at the same total dynamic head as it does handling water. The horsepower at this particular rating, however, would be .75 times the horsepower required for water when handling gasoline, and 1.2 times the horsepower required for water when handling the calcium chloride brine. This holds true for all cases where the viscosity of the liquid at its pumping temperature is the same as that of water.

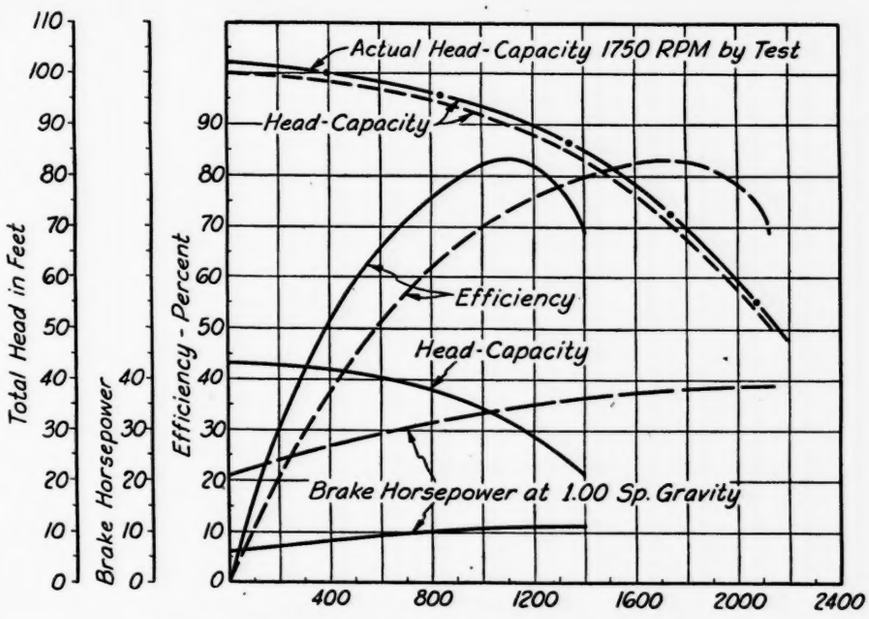


Fig. 3. Solid lines for 1,150 rpm; dash lines for 1,750 rpm (interpolation)

CHANGE OF PERFORMANCE

It may be well at this time to introduce the so-called laws of affinity relating to centrifugal pumps. These are theoretical laws or rules which apply to the change in performance of a centrifugal pump by a change in the speed of rotation or a change in the impeller diameter of a particular pump. It should always be remembered in using these laws of affinity that they are theoretical and do not always give exact results as compared with tests. However, they are a good guide for predicting the hydraulic performance characteristic of a pump from a known characteristic caused by either altering the speed of rotation or the outside diameter of the impeller. The laws of affinity may be stated as follows:

A. At a constant impeller diameter—

1. The capacity varies directly as the speed
2. The head varies as the square of the speed
3. The horsepower varies as the cube of the speed.

B. At a constant speed—

1. The capacity varies directly with the impeller diameter
2. The head varies as the square of the impeller diameter
3. The horsepower varies as the cube of the impeller diameter.

TABLE 1.—INTERPOLATION OF PUMP PERFORMANCE

1150 Rpm				1750 Rpm			
Gpm	Total Head Ft.	Hp	Effic., %	Gpm	Total Head Ft.	Hp	Effic., %
0	43.2	6.0	....	0	100	21.1	....
200	42.9	7.2	30	304	99	25.3	30
400	42.0	8.15	52	610	97	28.7	52
800	38.0	10.1	76	1220	88	35.6	76
1200	29.0	10.7	82.3	1825	67	37.7	82.3
1400	21.5	11.0	69	2130	50	38.7	69

Table 1 shows the interpolation of pump performance from 1150 to 1750 rpm. For example, the 400 gpm 1150 rpm point interpolates as follows:

$$\frac{1150 \text{ rpm}}{1750 \text{ rpm}} = \frac{400 \text{ gpm}}{x \text{ gpm}} \quad \text{or } x = 610 \text{ gpm at 1750 rpm}$$

$$\frac{(1150 \text{ rpm})^2}{(1750 \text{ rpm})} = \frac{52 \text{ ft hd}}{y \text{ ft hd}} \quad \text{or } y = 97 \text{ feet head at 1750 rpm}$$

$$\frac{(1150 \text{ rpm})^3}{(1750 \text{ rpm})} = \frac{8.15 \text{ bhp}}{z} \quad \text{or } z = 28.7 \text{ hp at 1750 rpm}$$

Example

In order to acquaint ourselves with these laws and to see their accuracy, let us take an example pertaining to a change in speed from a known characteristic at a known speed. In Fig. 3 we have given the actual characteristic of a centrifugal pump at a certain impeller diameter at a constant speed of 1150 rpm. Let us assume that due to changes in the system in which the pump is a part it is necessary to increase the speed of the pump. Since the pump is operating with a 60-cycle, 6-pole electric motor having a full load speed of 1150 rpm, the next higher speed on 60 cycle current is 1750 rpm. We shall therefore predict the performance of this particular pump at the increased speed of 1750 rpm by the affinity laws. See Table 1.

Results of our interpolation are plotted on Fig. 3 together with the

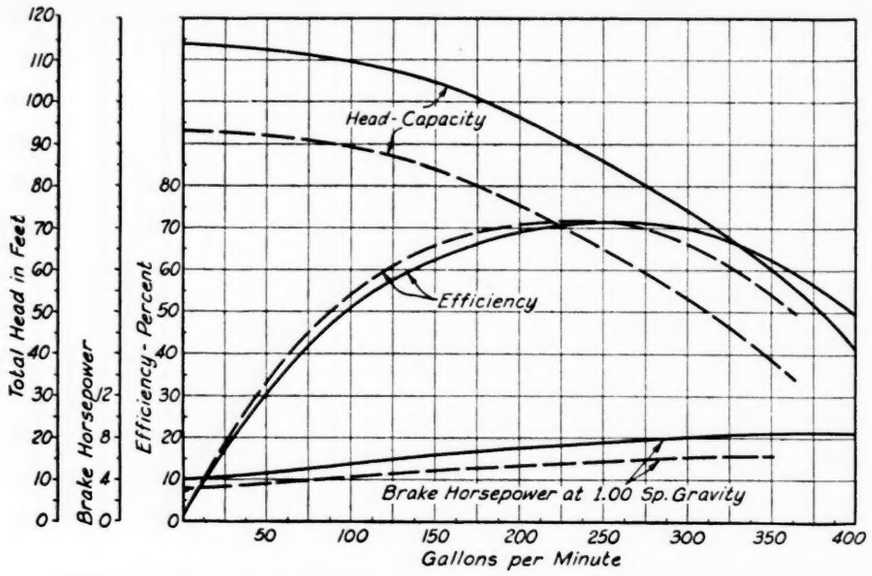


Fig. 4. Solid lines for 10.5 in. diameter impeller; dash lines for 9.5 in. diameter (interpolation)

performance curves at 1750 rpm actually obtained by test. By the affinity laws it is assumed that the efficiency remains unchanged, and we attribute some of the discrepancies found in interpolation to the fact we assume the efficiency remains unchanged whereas in reality it may not due to changed velocities and leakage losses within the pump. We can approximate very closely the performance of a centrifugal pump at another speed from a known characteristic and speed. The brake horsepower curve for the 1750 rpm performance can be calculated at various capacities by the formula for brake horsepower given previously, or it can be calculated by the 3rd affinity law regarding horsepower. It is shown a 40 hp motor would be required for this application if the capacity exceeds 800 gpm.

Interpolation by impeller diameter follows exactly the same procedure as the interpolation for speed. For example, in Fig. 4 we have given the operating characteristics of a certain pump at a constant speed fitted with a 10½ in. dia. impeller. If the impeller diameter is reduced to 9½ in. dia., we can anticipate a performance as shown by the dash line curve on Fig. 5. Calculations are tabulated below. If we reduce the impeller diameter to 9½ in. a 7½ hp motor will be required in place of a 10 hp originally required with a 10½ in. dia. impeller.

From the preceding we have a basic knowledge of the performance characteristics of a centrifugal pump.

CENTRIFUGAL PUMP SELECTION

We propose now to outline the steps for proper selection of centrifugal pumps based on what we have outlined regarding performance characteristics. All our calculations will be on the basis of handling clear, cold water having a specific gravity of 1.00. We will assume that the desired capacity or discharge of the pump in gpm has already been established.

Total Dynamic Head

In order to properly select a centrifugal pump for any installation, particular care must be taken in determining the total dynamic head of the system. Careful calculation of the total dynamic head is the most important element of centrifugal pump selection. This fact can not be stressed too strongly. The total dynamic head (TDH) consists of the following factors all added together to form a total.

1. Static suction lift (H_L) or suction head (H_P): the vertical distance in feet from the free level of the source of supply to the horizontal centerline of the pump.
2. Static discharge head (h_d): the vertical distance in feet from the centerline of the pump to point of free discharge; or, the level of free surface of the discharged liquid, or, in the case of discharging under pressure, the equivalent level of free discharge in feet of liquid.
3. Friction head (h_f): the head in feet of liquid required to overcome the frictional resistance of the piping and fittings of both the suction and discharge lines.

When the pump is above the source of supply and a static suction lift condition prevails,

$$TDH = H_L + h_d + h_f.$$

If, however, the source of supply is above the pump and the liquid flows to the pump by gravity, a static suction head condition exists and

$$TDH = h_d - h_p + h_f.$$

In determining the total dynamic head of a pumping system, the friction head and static head should be calculated at the maximum or extreme conditions of operation. In other words, the static head should be the maximum that will occur, and the friction head should be figured on the maximum capacity required by the system. The drawing of a system head or service curve is a recommended practice.

Example

Suppose we have to determine the total dynamic head of the following water system: Maximum capacity, 200 gpm; maximum static suction lift, 5 ft; maximum static discharge head, 30 ft; suction piping consisting of 10 ft of 4 in. pipe and one 90° 4 in. elbow; discharge piping consisting of 115 ft of 3 in. pipe, five 90° 3 in. elbows and one gate valve fully opened. A diagrammatic sketch of the system is shown in Fig. 5.

Let us plot the service curve of this particular system in Fig. 6. The total static elevation is 35 ft (composed of 5 ft static suction lift and 30 ft static discharge) as shown on the service curve. Our next step is to plot the friction head at various capacities. From water friction tables we secure the following information based on the pipe having a friction

TABLE 2.—INTERPOLATIONS WITH CONSTANT SPEED

10½ In. Dia.				9½ In. Dia.			
Gpm	Hd. Ft.	Hp	Effic., %	Gpm	Hd. Ft.	Hp	Effic., %
0	114	4.0	....	0	93	2.96	....
100	109.5	5.4	51	90.5	90	4.0	51
200	96	7.0	69	181.0	78.5	5.2	69
300	74	8.0	70	272	60.5	5.92	70
400	42	8.50	50	362	34.5	6.3	50

coefficient or smoothness factor of 15 year old pipe: One 4 in. 90° elbow is equivalent to 11 ft of straight pipe; five 3 in. 90 degree elbows are equivalent to 8 x 5 or 40 ft of straight pipe; one 3 in. gate valve fully open is equivalent to 1.5 ft of straight pipe. We have, therefore, on the suction of the pump an equivalent total of 21 ft of 4 in. pipe and on the discharge an equivalent total of 156.5 ft of 3 in. pipe. Our friction for the various capacities in the suction and discharge piping is calculated and tabulated in Table 3.

TABLE 3.—FRICTION HEADS FOR ILLUSTRATIVE PROBLEM

Gpm	Suction Pipe Friction	Discharge Pipe Friction	Total Friction
50	.07	2.16	2.23
100	.26	7.80	8.06
150	.55	16.6	17.15
200	.91	28.2	29.11
250	1.32	42.2	43.52

We next plot the friction head, Fig. 6, and find that at a capacity of 200 gpm we require a pump capable of 64 ft total dynamic head.

To carry the function of the service curve still further, we can plot also on our service curve the hydraulic performance curve of a pump which will develop 200 gpm at 64 ft total dynamic head. We can readily see that this pump can not pump more than our predetermined maximum capacity of 200 gpm since if we exceed 200 gpm our total head exceeds the head capabilities of this particular pump at 200 gpm. In other words, the friction head of the system throttles the pump to a maximum capacity of 200 gpm providing the maximum conditions of static head prevail. If, for example, the static suction lift might at times be zero or the water level at the suction source is level with the pump horizontal centerline, our total static head reduces itself from 35 to 30 ft, but, since we have not in any way changed our piping arrangement, our friction head remains unchanged. We can, therefore, plot a second service curve based on the minimum static suction condition. Therefore, when this suction condition exists, the pump capacity would be 212 gpm, and we could expect a varying discharge condition from 200 to 212 gpm depending upon the static suction conditions from 5 ft static lift to zero feet static lift. The horsepower requirement of the pump would vary from 4.8 hp at 200 gpm to a maximum of 5 hp at 212 gpm.

Logically enough, if we had used a larger size suction or discharge pipe, we would have had a total head of less than 64 ft at 200 gpm. If we had used smaller pipe, our friction head would have been greater, and we would have to use more power because of the greater friction head in the smaller pipe. Care and thought should be used in selecting the pipe size for every pumping job. The maximum static head is a fixed figure of unchanging magnitude. The friction head, however, is a variable which we can control by the size of pipe and fittings we use.

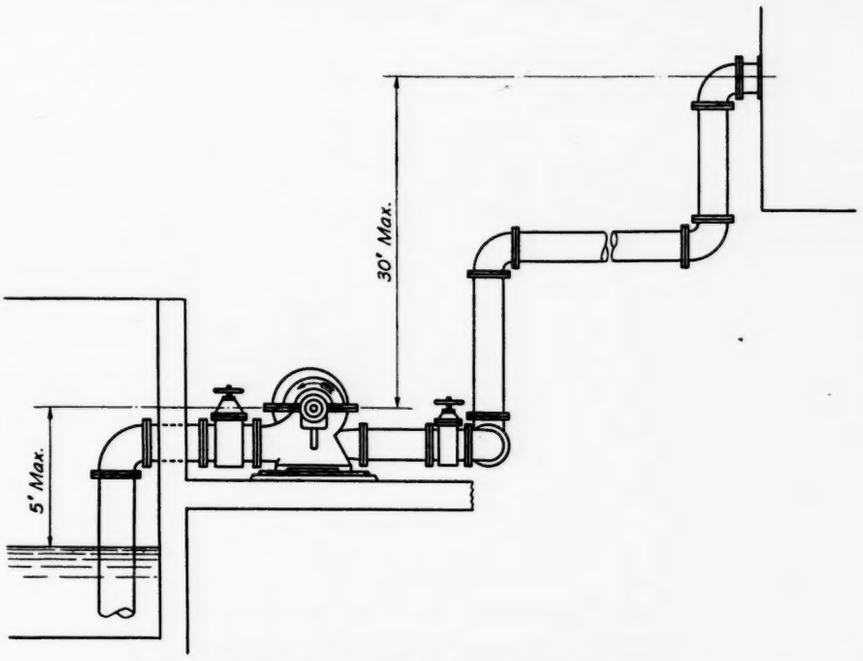


Fig. 5. Sketch of system in illustrative example

ECONOMICAL PIPE SIZE SELECTION

As for the size of pipe to be used, the selection should be based on cost, cost of pipe, and cost of power. A small pipe costs less but the friction is greater and this increases the power bill. A larger pipe in many instances will save more in power bills than the additional investment in the pipe will cost. Furthermore, the larger pipe may so reduce the total pump head that a lighter and lower priced pump and drive may be used. It is not unusual to see a pipe line several sizes larger than the pump discharge connection.

Example

An example of how to figure the most economical size of discharge pipe is given here to show how the problem can be worked out. A pump is to supply water at 100 gpm through a discharge pipe 1,000 ft long. While the size or kind of pump will not be taken up here, assume that the overall efficiency of pump and motor is 70% and that electrical power cost is 4 cents per kilowatt hour. Let us figure the least expensive size of pipe to use. Table 4 shows all the necessary figures.

Explanation: The cost of the pipe includes all labor and materials to put the pipe in place ready to use. The interest rate is 7%. The life of the pipe is about 25 years, at which time it must be replaced, so that 4%

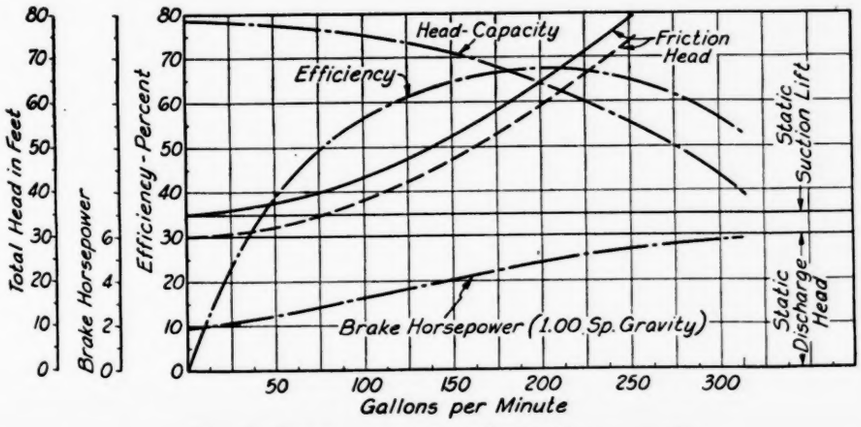


Fig. 6. Service curve for illustrative example.

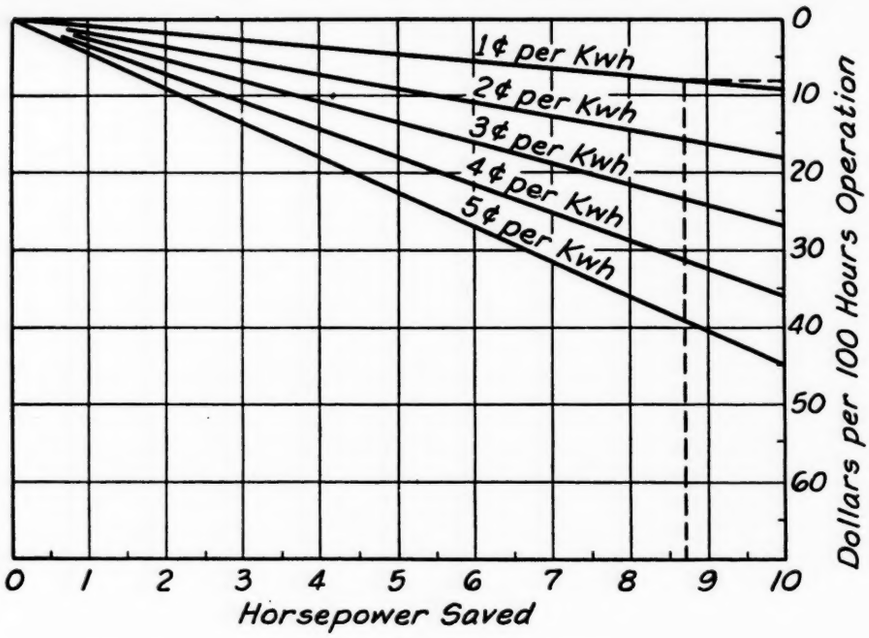


Fig. 7. Savings Chart

The lowest costs of these new totals would then give the size of pipe and the pumping equipment to buy. It should be noted that for continuous service, 8,760 hr per year, the 5 in. pipe is just about as economical as the 4 in. pipe, because for greater use the power cost runs up the total for the smaller pipe more than for the larger pipe.

Efficiency is an important factor to be considered in selecting a centrifugal pump. Efficiency is the key to the amount of power required by the pump. Power of course is money.

Fig. 7 shows at a glance what dollars and cents can be saved by replacing an old inefficient pump with a new and more efficient unit. Figures given are approximate as an average motor efficiency of 85% is assumed, and the power factor and the demand charge are not considered. The curve, Fig. 7, will, however, indicate to what extent a new pump will be an advantage in any

of the cost of the pipe must be put aside each year to take care of this. Also 1% is here allowed for minor repairs, painting and usual maintenance. Thus a total of (7 + 4 + 1) or 12% must be paid out or laid aside each year to pay for the use of the pipe. The third column of Table 4 shows this yearly pipe cost. Pipe friction is taken from tables and multiplied by 10 for 1000 ft of pipe because the tables show values for each 100 ft of pipe. The horsepower for driving the pump is calculated from formula. For column 5 this is first changed to kilowatts (kw) by multiplying by 0.746, and then multiplied by the number of hours each year in which the pump is running, in this case taken at 10 hr per day for 300 days each year or a total of 3000 hr. Thus the figures in column 5 come from the formula below.

With power costs at 4 cents per kwh the figures in column 6 follow immediately. The total cost each year for the pipe and power is then the sum of columns 3 and 6 and this total is shown in column 7. In this case, then, the 4 in. pipe is the cheapest. If, however, the use of a 5 in. pipe with its lower pipe friction makes it possible to buy a cheaper pump and motor, it might be possible to save more than the difference between $315 and $373 or $58 per year by this means. It would require about $400 reduction in pump and motor cost to make this up, so in this case it would not be possible.

For a complete picture of the costs of the job, a pump and motor should be selected for each size of pipe, its cost found, and about 15% of its cost added to the totals of column 7 for the use of the pumping equipment.

TABLE 4.—PIPE COSTS

Size of Pipe	Cost of Pipe Installed	12% of Pipe Cost	Pipe Friction Feet of Head	Kwhr per Year Lost in Pipe Friction	Cost of Power @ 4c per Kwhr	Total Cost per Year
2"	$800	$96	358	28,900	$1156	$1252
2½"	1150	138	120	9,700	388	526
3"	1500	180	49.6	4,000	160	340
4"	2300	276	12.2	987	39	315
5"	3000	360	4.1	331	13	373

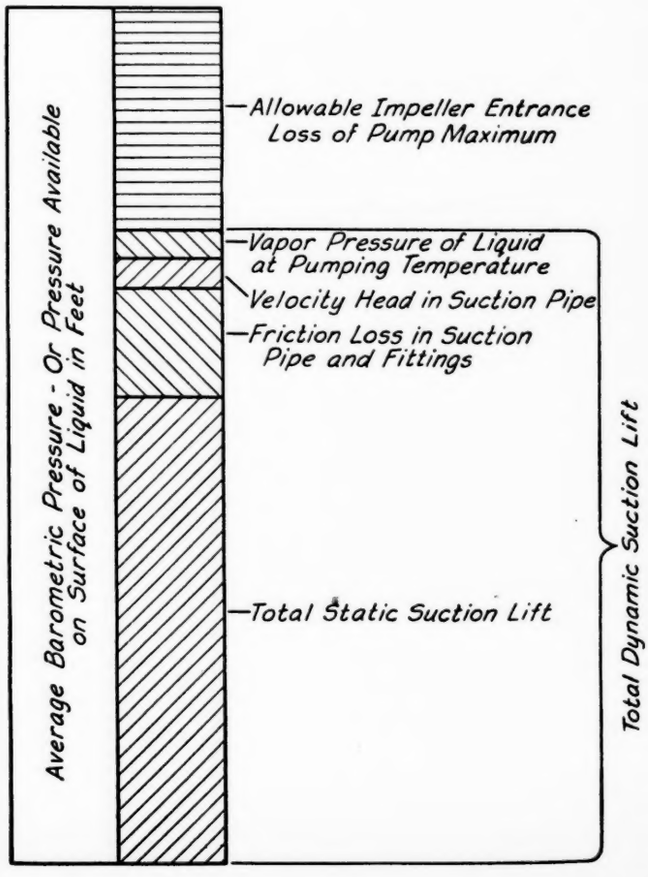

Average Barometric Pressure - Or Pressure Available on Surface of Liquid in Feet
Allowable Impeller Entrance Loss of Pump Maximum
Vapor Pressure of Liquid at Pumping Temperature
Velocity Head in Suction Pipe
Friction Loss in Suction Pipe and Fittings
Total Static Suction Lift
Total Dynamic Suction Lift

Fig. 8. Suction lift details.

$$\text{kwhr} = \frac{\text{gpm} \times \text{head}}{3960} \times \frac{1}{.70\ (\text{efficiency})} \times 0.746 \times 3000$$

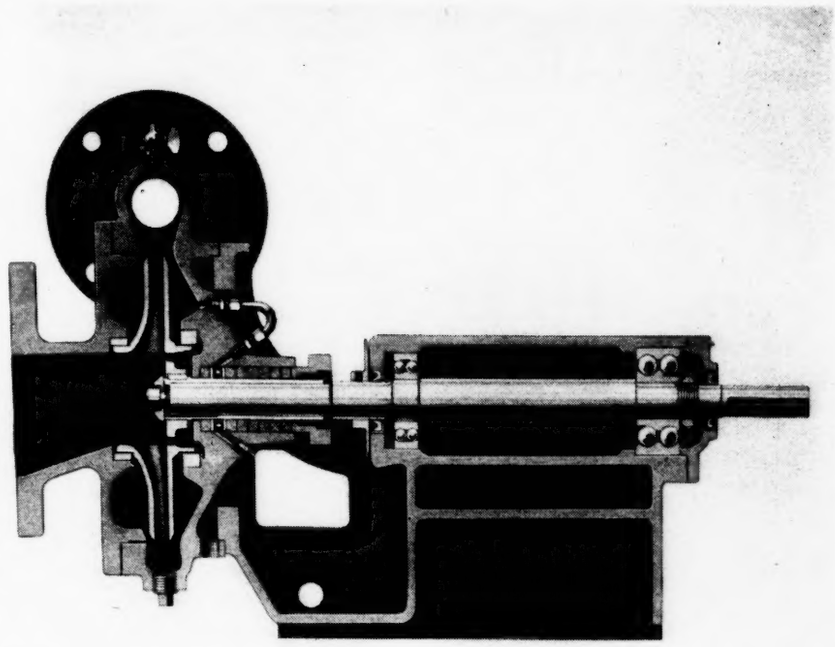


Fig. 9. Single suction pump

installation where an improvement in the efficiency is made. Quite often the new more efficient pump will pay for itself in a few months from the savings and will provide the customer with a clear gain thereafter.

To use chart:

1. Calculate Brake Horse Power of old pump and of new pump.

$$BHP = \left(\frac{\text{Gallons per min.} \times \text{total head in feet}}{3960 \times \text{pump efficiency expressed as a decimal}} \right) \times \text{specific gravity of liquid}$$

2. Read up from "hp saved" line (i.e. difference between old and new pump hp) to line marked with nearest electric current rate.

3. Then read across to the right for dollars saved. This is per 100 hours from which savings for any period may be figured.

Example

An example as to the use of the chart follows:

Rating—750 gpm
Total dynamic head required by the pump—200 ft
Power rate—$.01 per kwh
The old pump efficiency at the rating—69%
The new pump efficiency at the rating—82%
Old pump brake horsepower—54.9
New pump brake horsepower—46.2
Horsepower saved—8.7
Saving per 100 hours operation—$8.00

Assuming the pump operates ten hours per day, 300 days per year or 3,000 hours per year, our net power saving per year would be

$$\frac{3{,}000 \times 8}{100} = \$240 \text{ per year}$$

SUCTION LIFT LIMITATION

The suction lift capability or limitation of a centrifugal pump is in inverse proportion to the pump capacity. For many years 15 ft total dynamic suction lift has been more or less set as a maximum for centrifugal pumps. Centrifugal pumps, however, are capable of much higher suction lifts when properly selected. The suction lift capability of all pumps is dependent upon the pressure available on the surface of the liquid at the source of supply. It follows therefore that at sea level where the barometric pressure is 14.7 lb per sq in absolute or equivalent 34 ft (14.7 × 2.31 = 34 ft) the maximum theoretical suction lift on cold water assuming no frictional losses is 34 ft. This figure, of course, can never be obtained in practice. As stated, the suction lift capability of a centrifugal pump is a function of the capacity.

Excessive suction lift causes a reduction in pump capacity, noisy operation, vibration and erosion or pitting of the impeller and other parts of the pumps. Pumps working under excessive suction lift are said to be in cavitation. Cavitation, by definition, is that phenomenon whereby liquid is vaporized by reduction of pressure below the vapor pressure or vapor tension point of the liquid. The bubbles of vapor so formed at the eye of the impeller, upon flowing into a region of higher pressure within the impeller, collapse. The collapse of the vapor bubbles and the resultant inrush of liquid into the cavities or spaces left by the collapsed bubbles causes a reduction in capacity and efficiency, and results in noisy operation. In effect, cavitation is caused by the fact that the total dynamic suction lift and losses into the pump have so reduced the pressure on the liquid that the liquid is in a state of breaking in vapor, and centrifugal pumps of the conventional volute type are not able to handle satisfactorily air or vapor in any appreciable amounts. It is highly important, therefore, if we expect to obtain satisfactory performance from a pump, that we carefully analyze conditions on the suction side of the pump for every application to be sure that the unit will not operate in a condition of cavitation.

We outline the data a pump manufacturer should always be given regarding the conditions of operation on the suction of every centrifugal pump application.

1. Static suction lift to centerline of pump or suction head above centerline of pump.
2. Length and size of suction pipe.
3. Size, type and number of pipe fittings, elbows, etc., on the suction line.
4. Liquid to be handled and the maximum expected pumping temperature.
5. The average barometric pressure or approximate elevation above sea level. In the case of closed vessels, the vapor pressure of the liquid at its pumping temperature and the minimum pressure in the vessel.

With the above information the pump manufacturer can select the proper pump in his line to operate satisfactorily under the required condition without danger of cavitation. It is necessary that the addition of the total equivalent dynamic suction lift and the dynamic entrance losses into the pump do not exceed the pressure available on the surface of the liquid at the source of supply as shown in Fig. 8 for units working under static suction lift. Units to pump liquids at or near their vapor tension points must always be installed with the pump below the source of supply.

For units working under a static suction lift let us take a hypothetical case:

Capacity—8,000 gpm

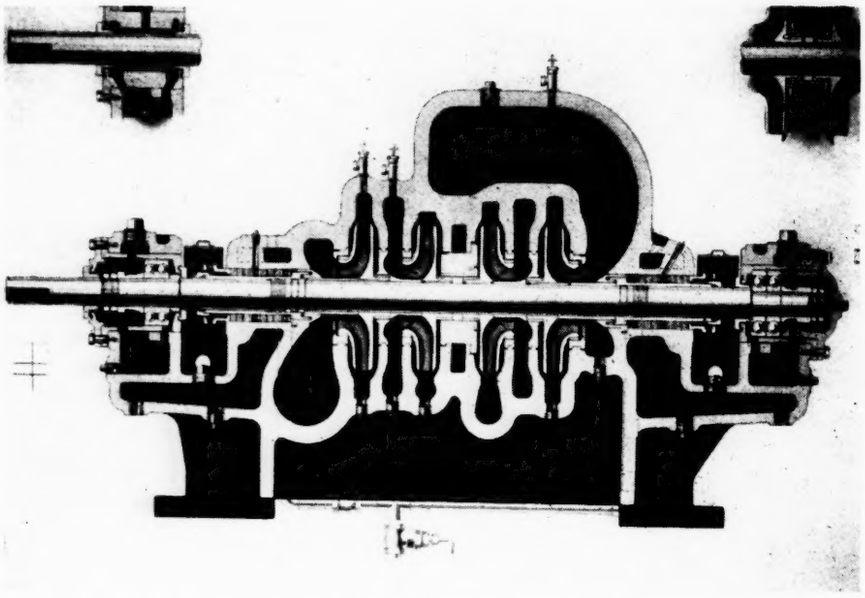


Fig. 10. Multi-stage pump

Liquid—water at 85F maximum temperature
Static suction lift—15 ft
Suction piping—22 ft 16 in. pipe (cast iron)
1 90 degree 16 in. elbow
1 16 in. gate valve (full open)
Elevation—3,000 ft above sea level.

We find that for this application the friction loss at 8,000 gpm in the suction piping amounts to 3.45 ft. The velocity v of 8,000 gpm in 16 in. cast iron pipe equals

$$\frac{8{,}000 \times .4085}{16^2}$$

= 12.8 ft per sec. The velocity head (h_v) therefore equals $\frac{v^2}{2g} = \frac{164}{64.4} =$ 2.55 ft.

From steam tables we find the vapor pressure of 85F water to be 1.213 in. of mercury which is converted into feet head by multiplying by 1.113 or 1.37 ft head. We therefore total our suction losses consisting of 15 ft static lift, 3.45 ft friction loss, 2.55 velocity head loss, 1.37 ft correction for temperature to form a total of 22.37 ft total dynamic suction lift. At an elevation of 3,000 ft the barometric pressure will average 26.8 in. of mercury transferred into feet by multiplying by 1.133 equals 30.4 ft equivalent atmospheric pressure. By subtracting our total dynamic suction lift from our equivalent barometric pressure in feet (30.4 ft — 22.37 ft), we find that the allowable dynamic entrance loss is 8 ft. The pump builder therefore must select a unit from his line whose impeller entrance loss is 8 ft or below. If a pump is selected whose impeller entrance loss exceeds 8 ft at 8,000 gpm, the pump will operate in cavitation, or will probably lose its prime and be otherwise unsuccessful. The pump manufacturer conducts special tests of his units to determine the impeller entrance losses at various capacities and speeds, and these tests are his index to the suction lift capabilities of pumps of his manufacturer. The suction lift capability of a centrifugal pump decreases as the capacity increases, as previously stated, so that on extremely high suction lifts a pump may be selected of a larger size than would be normally used for lower lift due to the fact that the larger pump selected has lower impeller entrance losses and consequently higher suction lift capabilities than a smaller unit for lower suction lift.

It is not within the scope of this article to go into the application of centrifugal pumps handling liquids at or near their vapor tension points such as pumps for boiler feeding, hot well condenser service, or the handling of volatile liquids or refrigerants. These are special applications. However, if for each application the centrifugal pump manufacturer is given the data outlined previously as to the conditions of operation on the suction side of the pump together with all the conditions of discharge, he can readily apply the proper unit from his line to the application. Remember always that a simple diagrammatic sketch of an installation is worth more than two pages of complicated description.

PUMP TYPES

There are essentially three types of volute centrifugal pumps, namely the single suction, double suction and multi-stage. The single suction pump, shown in Fig. 9, is usually of the cantilever type with the impeller mounted on the end of an overhung shaft. The double suction type of pump consists essentially of two single suction impellers in one casting mounted equidistant between two bearings. The multi-stage pump, Fig. 10, is a unit of two or more impellers on one shaft. The impellers may be of the single or double suction type or a combination of a single suction and double suction impellers.

Single and Double Stage Pumps

The single suction type of pump is used for the smaller capacity ranges, approximately 10 to 2,000 gpm. The double suction type of impeller can be obtained in capacities from approximately 100 to 100,000 gpm. From approximately 100 to 2,000 gpm, either a single suction or double suction type of pump could be used. The advantages of the single suction pump over the double suction pump are briefly:

1. Lower initial cost.
2. One stuffing box instead of two; fewer parts thus requiring less maintenance.
3. Less floor space.

The advantages of the double suction pump over the single suction pump may be summarized as:

1. Possibility of higher hydraulic efficiency and therefore lower operating cost.
2. Possibility of the pump being able to operate under higher suction lift than a single suction pump for the same capacity.
3. Pump may be disassembled and the rotating element removed without disconnecting the suction and discharge piping.
4. The double suction pump having the impellers suspended between two bearings is of an admittedly better mechanical construction than the single suction pump with a cantilever or overhung load.

Multi-stage pumps are used for applications requiring high discharge pressure, for example: Vertical deep well pumps, horizontal boiler feed, etc. The multi-stage pump is essentially a number of pumps in one as it consists of two or more impellers. The pressure developed by the first impeller is augmented by the pressure of the succeeding impeller or impellers to form a total discharge pressure equal to the sum of the pressures developed by each of the impellers. The capacity of a multi-stage pump at the discharge is the capacity of one impeller.

Although this article has treated the subject of centrifugal pumps in a general sense, the data and information herein contained can be applied for nearly all general service and circulating applications within the heating, ventilating and air-conditioning industry.

Under Floor Condensation

AT the Department of Agriculture Bureau of Plant Industry Station, Beltsville, Md., is one of the largest collections of wood fungi in the world—growths that affect standing timber and the deterioration of forest products. The collection is used as a basis for determining unknown fungi in cases under investigation and to produce decay in laboratory experiments on preventive methods.

Under study at this station is the problem of the amount of ventilation needed to prevent decay of sills and floors of structures that have been built close to the ground and without basements. Many war housing projects throughout the country were built on wet sites with resultant danger from decay. There are also thousands of country houses, farm homes and beach houses built without basements, or with only partial basements.

"Where the soil is moist and there are temperature differentials sufficient to promote condensation on sills and joists, ventilation is needed under houses that have no heating distribution system beneath the floor, in order to safeguard against decay," says Dr. J. D. Diller of the station. Experience has been that a central heating plant below the floor but without subfloor distribution pipes can actually increase the condensation hazard because it vaporizes moisture from the soil near the heating plant but does not make the sills or joist headers warm enough to keep the vapor from condensing.

Heating plants of the houses under study are for the most part warm air furnaces, with forced circulation, the furnace being installed above the floor. In three houses under study the furnaces were beneath the floor suspended from sills and joists, but the hot air passes directly into the building instead of being distributed by subfloor pipes. Six other structures receive steam from a central plant, the conducting pipes running the full length of the building beneath the joists.

Soil conditions under the houses observed range from sand or perceptibly dry clay to sticky clay that holds standing water at times. During a part of the study three buildings have been unoccupied. It was found that heating from conducting pipes beneath the floors by steam is very effective in lowering the moisture content of the sub-construction timbers, even in houses with wet soil conditions and no ventilation area.

Moisture measurements of sills and joists are obtained with an electrical resistance moisture meter, by which approximate moisture content up to 36 per cent can be read. The contactor unit consists of a handle with two 5/16-inch penetration needles which are forced by hand pressure into the wood full length at right angles to the grain. The instruments were calibrated by C. S. Moses of the Department by comparison with over-drying determinations. Relative humidity and temperature readings are obtained with a hand aspirated psychrometer at different times of day. Some checking has also been done of the psychrometer readings by use of hygrothermograph instruments, which also served to indicate daily fluctuations of relative humidity and temperature, as well as the effect of opening and closing of vents. Every moisture value results from an average of three readings, all taken within an area of approximately a square foot. Whenever possible both sill and joist readings are included in this average, all readings being corrected for temperature to a 70F base.

Winter condensation is usually on the sills and ends of the joists, on the north or northeast side of the house, while in the summer it has been seen at the centers of the floor instead. Further along in the studies, an asphalt roll roofing of 55 lbs per square foot and asphalt building felt of 15 lbs per square foot were used as soil covering at the suggestion of T. C. Sheffer. For four of the buildings under study the soil was completely covered and for others only 50 per cent. The tests show that where it is impracticable to provide sufficient under ventilation, and condensation occurs, it can be prevented and the wood moisture kept below the rotting point by covering the soil with the asphalt roofing.

During the war much lumber was found infected with fungi, due to lack of care in piling and cutting and use of poor timber already infected. Such lumber has a tendency to decay when used in structures that have no cellars or sufficient under floor ventilation.

When Cold Water Lines Ran Hot

By JOHN J. WOOLFENDEN

Engineering Staff, Smith, Hinchman & Grylls, Inc., Architects and Engineers, Detroit, Mich.

An engineer's experience in locating the cause for this trouble in an office building.

IT has often been said that a fluid in motion will select the path of least resistance. With that statement there can be no argument, but it is not always easy to determine, beforehand, what that path will be, in spite of the fact that, in many cases, there seems to be no room for doubt.

Given a straight, vertical steel pipe of three inches nominal diameter, perhaps six feet in length, open to atmosphere at the upper end and connected to a large tank at the lower end and without restrictions, terminal or otherwise, excepting those due to the slight irregularities in standard fittings. Given, also, the fact that there are two pipes connected into this vertical pipe, one above the other; the upper one, 1¼ in. in size, about three feet above the tank on the north side and the lower one 3 in. in size, about a foot lower, on the east side. If asked what would be the path of water entering the vertical pipe through the upper (1¼ inch) pipe, what would your answer be? That it would drop down the vertical pipe, into the tank?

That would be the logical conclusion from the evidence presented, but in one case, at least, that is exactly what the water did *not* do.

And would you believe it, if you were told before it happened, that it would not flow into the tank? Probably not, and the failure to appreciate that the most obvious path is not necessarily the easiest path, enshrouded in mystery a relatively simple physical phenomenon and, after two weeks of fruitless investigation, the solution would still have been as remote as ever, but for an accidental coincidence.

About seventeen years ago, the design of an office building called for a domestic water supply tank to be located in the upper portion of the pent house.

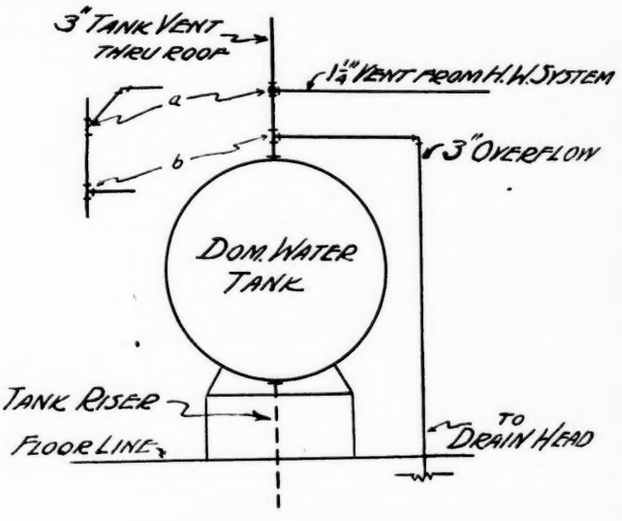
Building Eight Stories High

There was nothing unusual about the installation. The building, itself, was eight stories in height and, of course, was provided with a booster pump for domestic water supply in the basement. As the offices were intended for occupancy by doctors or dentists, the hot water, cold water and compressed air systems were quite extensive and were so arranged that any or all of the offices could be provided with any or all of those utilities.

The booster pump, itself, discharged into the "tank riser" which entered the tank on the under side. The tank, itself, was of the horizontal type, 54 inches in diameter by 15 feet long.

The vent from this tank, taken off the top, ran straight through the roof, to atmosphere, and was connected, by a short horizontal run of 3 in. pipe to a vertical run, also 3 in., which was located a foot or so away from the tank and ran downward, terminating in an open end, over a drain opening, below. This pipe, in connection with the vent pipe up to its point of connection, served as an overflow pipe, in case the water level control should fail to function.

The supply inlet to the tank was at the bottom, where the tank riser was connected, the supplies to the various floors being run by means of branches taken off this same riser.



Arrangement of piping at tank.

The hot water supply was taken from the water heater in the basement, itself supplied from the domestic cold water system, and carried up to the various floors by means of risers connected to a basement supply main. These risers were vented, at their tops, by a connection run from each to collecting mains in the attic space which, in turn, made a 1¼-in. connection to the tank vent, as above described.

As the city water pressure was inadequate to raise the water to the upper stories of the building, the supply to the water heater was taken from the discharge side of the booster pump. The general arrangement is shown in the accompanying sketch.

As will be seen, there is nothing in the arrange-

ment which would justify the expectation of trouble or complaint.

Nevertheless, a short time after the tenants had begun to move in, a complaint was received stating that at numerous times there was no cold water available and that the cold water lavatory and other fixture supplies discharged *hot* (not warm) water.

Such a condition might bring about serious results, as the injury of a tenant, through scalding, could furnish grounds for a damage suit.

No Apparent Cause for Trouble

An examination of the plans disclosed no apparent cause for such an occurrence and a visit to the building was no more productive of results, as everything appeared to be functioning normally, with cold water in the storage tank and all faucets delivering water at the proper temperatures.

Even though several hours were spent, waiting to see what might happen, nothing out of the ordinary was found.

A day or two later, another complaint was received and a second visit to the building was immediately made, but again without results.

A member of the contracting firm which installed the system, whom we will call X, was consulted and, although this gentleman had been previously, for years, a professional engineer and was a man of wide experience, he could arrive at no satisfactory conclusion.

In the meantime, more complaints were received and further visits to the premises made, still without any satisfactory progress toward the solution of the problem.

Finally, the two of us met at the building and went over the entire installation of hot and cold water piping, from basement to pent house, but could find nothing indicative of the source of trouble.

As we were standing in the pent house, discussing the matter, X leaned up against the vertical drop pipe, with his hands crossed, behind him, against the pipe. Suddenly he sprang away, with an exclamation.

"What's the matter?"

"Why, that pipe suddenly got hot!"

Sure enough, it was, and too hot to hold the hand on, without discomfort.

"Something has happened within the last minute or two which wasn't 'doing' before, and I am going to find out what it is," said I, and immediately went down to the machine room in the basement to find the janitor.

Booster Operation Gives Clue

In response to the question as to what had taken place within the last five minutes that hadn't been going on previously, the reply was "nothing."

This was not a satisfactory answer, nor could it be correct, as there certainly had been a change of some kind in the conditions. No reference was made to what had occurred, lest even a correct statement of the circumstances induce the following of a false lead, but further information was required and was insisted upon.

Finally it occurred to him that the booster pump had operated within that period. A moment's reflection, and the problem was solved—as to cause.

The hot water main, serving the upper stories, was, of course, on the booster system; i.e., the supply to the water heater was taken off the system on the discharge side of the booster pump. When the pump was in operation, the resulting increase of pressure caused a rise in water level in the hot water system, in order to balance this pressure, and this rise was sufficient to cause the hot water to fill the vent loop and run over into the vertical pipe.

Water Entered Vent Pipe

As to effect, however: why didn't the water all flow vertically down the 3-inch vent pipe and discharge wholly into the tank? That it had not was evident; else the overflow pipe would not be hot. Perhaps some of it did. However, as the exact proportioning of the flow, if any, was at that time of no particular interest and had no direct bearing upon the investigation, no attempt was made to determine it.

There is apparently but one logical explanation for the phenomenon: viz., that as the pump started up, the pressure developed would be greater than the normal operating pressure and the hot water level would rise to the height required to balance this pressure. The first influx of hot water into the 3-inch vent pipe would not be a solid stream, but a trickle, or dribble, and that this, clinging to the inside surface of the vertical pipe, followed the surface into the branch of the tee to which the overflow pipe was connected and thus entered the drop pipe. The compensating head would depend upon the hot water temperature which, in turn, would depend upon the preceding hot water demand; hence the lack of periodicity in the occurrence.

Furthermore, the relief of the hot water through the vent pipe, at least in the initial period, must have been adequate to prevent the building up of a pressure head to force it through, otherwise it would have "spurted" and not flowed on the surface.

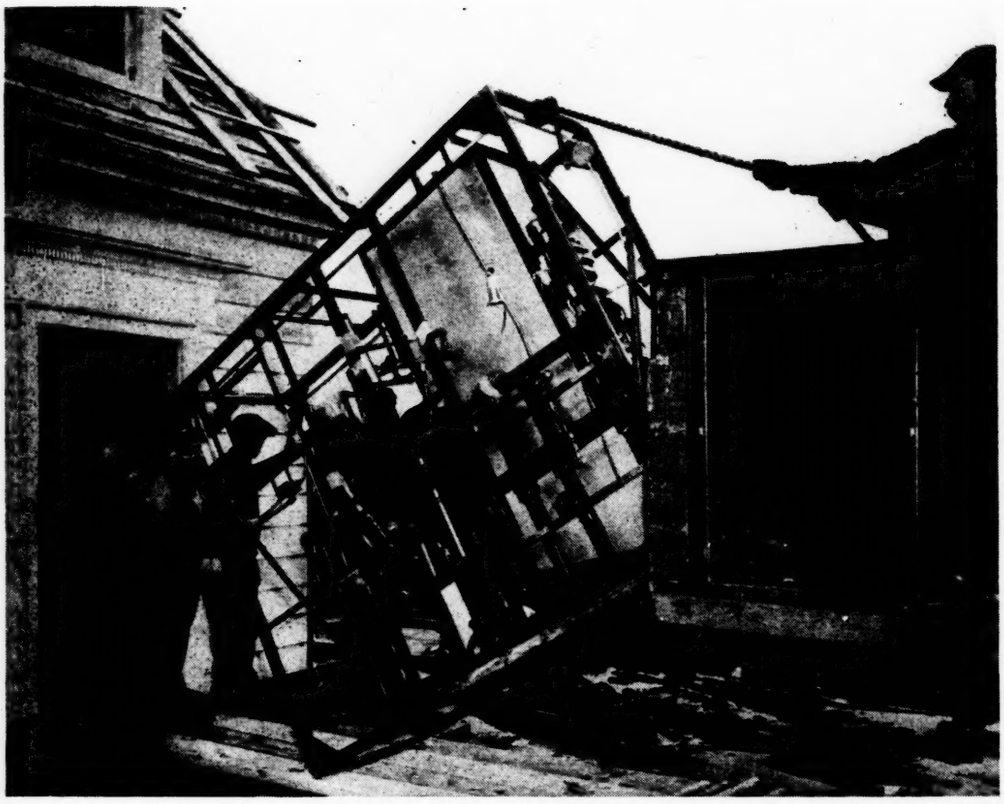
Simple Correction Required

The remedy? Simply to change the piping so that the hot water could not flow into the vertical vent pipe.

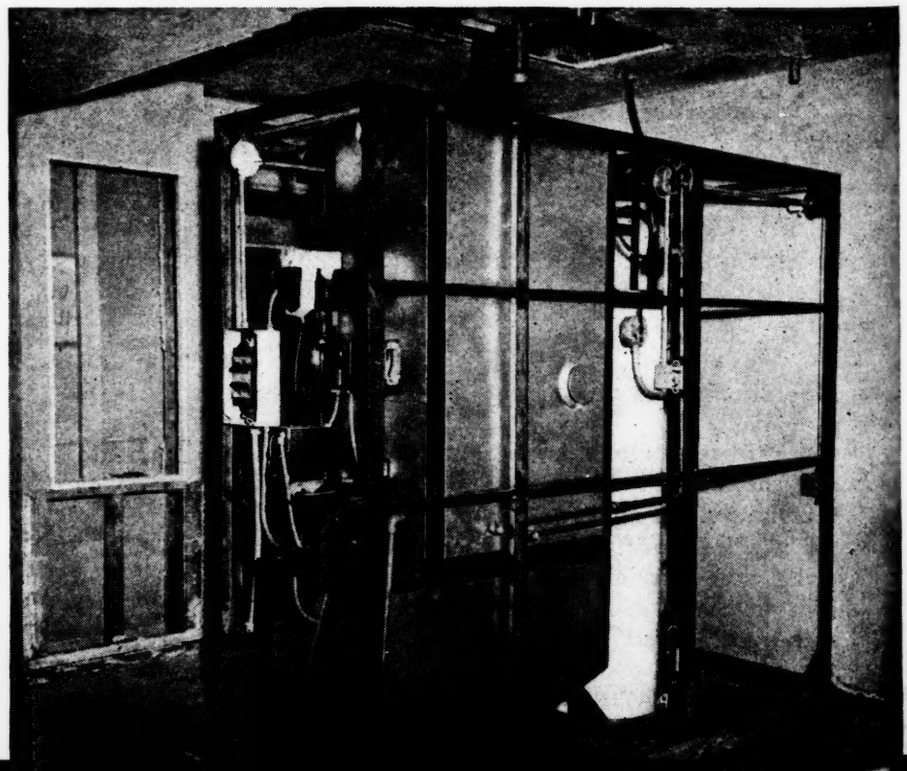
Note:—About a month ago, information was received that the cold water in this building was again "running a temperature." In view of the piping changes made sixteen years ago, this indicated that some other part of the system must be at fault. A later report stated that investigation had disclosed that a combination faucet in one of the upper stories had become defective and that a cross-connection between the hot and the cold water systems had resulted.

Roll in Your Domestic Services

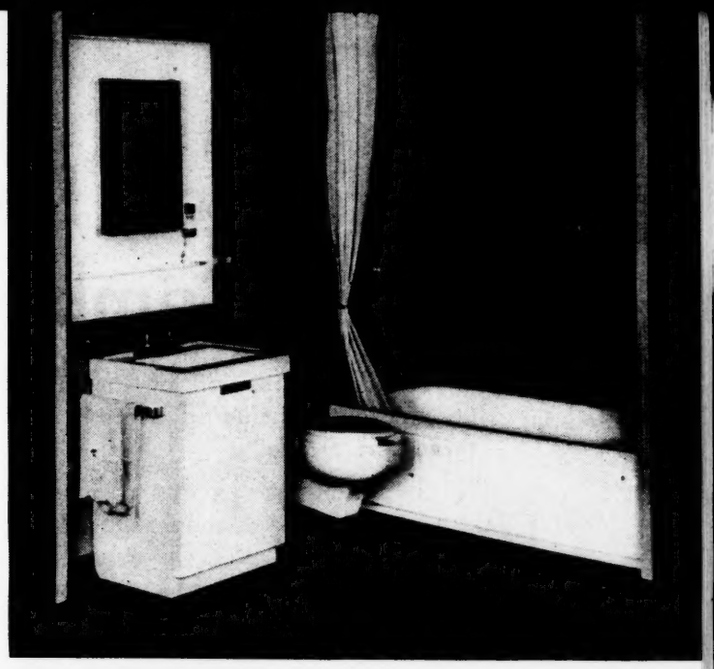
Central portable core provides house with heating, kitchen, laundry and bathroom facilities.



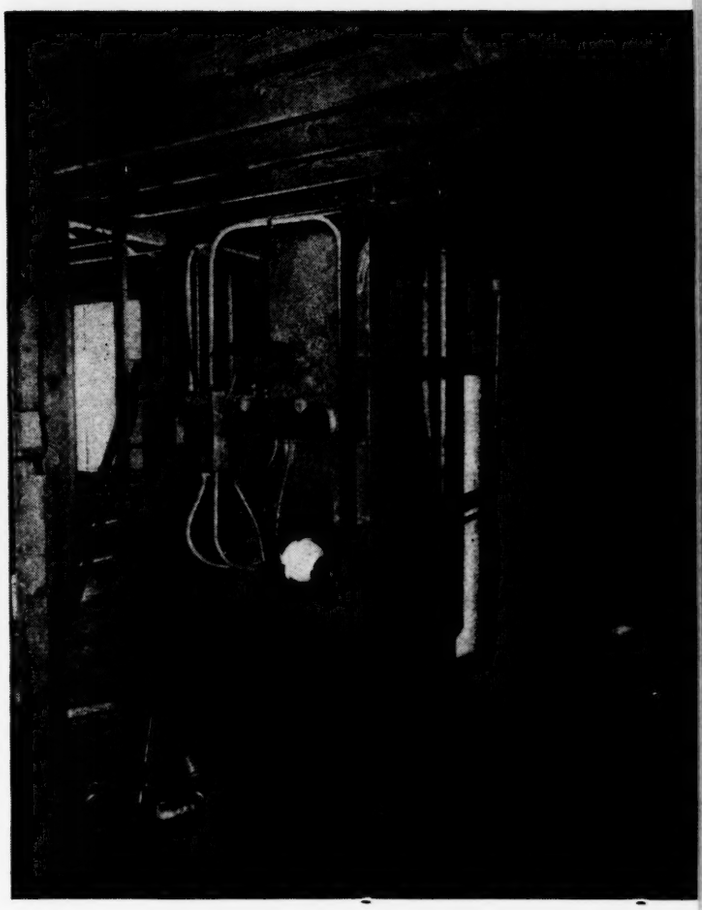
Ingersoll utility unit which combines space and water heating, plumbing, refrigeration, kitchen and bathroom facilities, has been designed by Ingersoll Steel Division, Borg-Warner Corp., Chicago, and is being installed in test homes at Kalamazoo, Mich. Core frame of welded steel measures 90 in. long, 77 in. high and 30 in. wide. It can be unloaded from truck and rolled to position in house. Core contains 80,000 Btu output steel warm air furnace for oil or gas fuel, water heater, flues to chimney, soil piping, copper hot and cold water pipes, copper oil and gas pipes, electrical conduit controls and connections. Around three sides of core are assembled component parts of kitchen, laundry and bathroom.



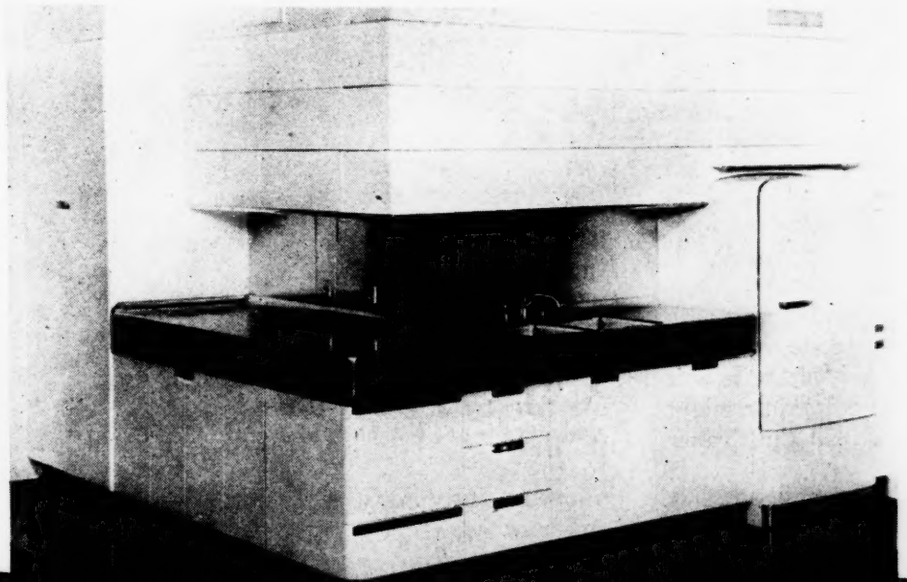
Kitchen-laundry side of utility unit core. At left are the furnace and air filter, blower, fuel pump, electrical lines and controls. Water heater is at the rear. Electrical system is a series of rigid metal conduits fed into a distribution box which contains circuit breakers. Motor controls are accessible. Each circuit carries less than 60% of its capacity so that additional load can be added. Extra circuits are provided for an electric range and an electric water heater.



Bathroom supplied as part of the unit, contains recessed tub-shower combination and fittings. In center is a toilet with low pressure flush valve. Wall paneling is attached to side of utility core and is arranged to provide access to concealed utilities.



Central core in position in one of the test houses. Photograph provides a better view of the electrical system and control boxes. Oil furnace has a pot type burner with air supplied by an auxiliary blower. Oil and gas furnaces have an automatic heat circulating fan and thermostatic limit switch which prevents overheating. Warm air is forced through ducts to the various rooms. Gas and oil burners, blowers, and replaceable filters are accessible, and can be removed for servicing. Where possible, pipe fittings are eliminated by pipe bends. System is completely valved so that adjustments can be made to water heater piping without interrupting water service to kitchen, bath and laundry.



At left is laundry with appliances and fixtures concealed under work counter. At corner is gas or electric stove, then sink, work counter, and refrigerator. Cabinets and work counters are steel with baked porcelain enamel finish.

Air Cleaners for Internal Combustion Engines

Effect of the position of the air intake is taken up in this concluding section of Dr. Silverman's three-part article.

LESLIE SILVERMAN

Department of Industrial Hygiene, Harvard School of Public Health, Boston, Massachusetts

IT cannot be too strongly emphasized that the position of the air intake is of the utmost importance, if satisfactorily cleaned air and, consequently, long and satisfactory engine life are to be secured. Tests have shown that not all possible positions for the air intake of automobiles, trucks and tractors are equally dusty. In one case the time between servicings of the air cleaner on a certain small tractor was increased from one day to ten days by simply taking the air in through a stand pipe extending 2 ft above the regular low intake position. Long

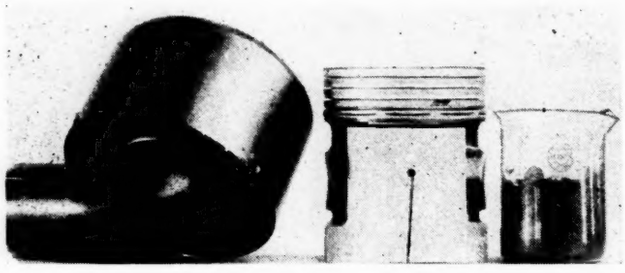


Fig. 15. Dry centrifugals do not protect sufficiently. Air cleaner and piston from a 1928 six-cylindered automobile used by the California Highway Commission near Oroville. After 3,478 miles 0.015-inch over-size pistons were necessary. Note gaps between rings and grooves. The dust in the beaker was removed from carbureter and connecting tubes after 100 miles of use.

tubular connections or 'periscopes' used for drawing cleaner air from higher levels, are undesirable on automobiles and trucks because the inertia of the long air column tends to make the engine sluggish when the throttle is opened suddenly. Also the added restriction is more deterimental where wide variations in speed and engine load are the rule, as in road vehicles.

The direction of the air inlet with reference to the direction of the fan blast is also of considerable importance. This is shown in Figs. 16 and 17.

Fig. 18 illustrates various possibilities of carburetor inlet placing and shows why different amounts of dust are taken in. Most late type carburetors are of the down draft type mounted above the manifold. The illustrations show locations for updraft carburetion, but the suggested locations for the air inlet and cleaner are still applicable. If no air cleaner is to be used, arrangement A is preferable to B. If an ordinary dry centrifugal with ejector slots and without rotor is used, it should be placed as in F. If the cleaner is placed as in E it becomes in effect a 'dust scoop' and more dust might enter the carburetor than would go in if the cleaner were left off. This arrangement is found in one air cleaner designed for a certain late model car. Arrangement D is probably little, if any, better than E. Whether C or G is preferable depends upon which side of the engine the air inlet is placed. Usually G is to be avoided. As indicated in H, the radiator fan throws the air stream somewhat upward on the side of the engine on which the fan blades rise and downward where the blades descend. If the air inlet is placed on the descending side arrangement C may possibly be preferable to F. It should be remembered also in this connection that objects in the air stream, for example, starting motors, spark coils, etc., act as partially effective dust shields for the spaces immediately back of them.

Cleaners without protecting shell also are considerably affected by their position relative to the fan blast. The blast striking an unprotected side of one of these cleaners quickly removes the oil from the filter material on that side and drives in the dust. This results in lower efficiency and earlier need for servicing. When such cleaners are placed in the horizontal position, usually the end plate serves as a protecting screen. If they must be placed in the vertical position, a cylindrical or half-cylindrical shield may be used to advantage.

When the fan is shrouded or when it is located very close to the radiator core and there are louvres in the hood, that portion of the space under the hood above a line drawn from the topmost point of the shroud and the rear end of the hood center line (hinge) is most nearly free from dust. The dust is usually the thickest at the location of the car-

Fig. 16. The air inlet should not face the fan blast. In a road test lasting three years it was found that 3.5 times as much dust per mile was caught when the inlet faced forward as when in the position shown.

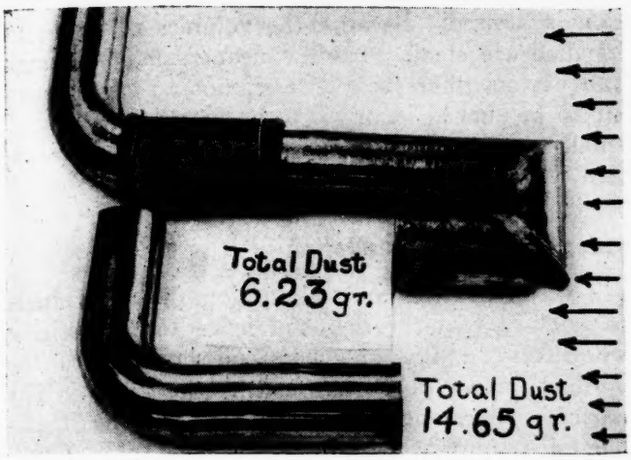


Fig. 17. The effect of the direction of the inlet. In two laboratory tests, alike except that in one the inlet faced the air stream while in the other, the return-bend faced down stream, the ratio of dust taken in was 2.35 to 1.

buretor, in spite of which air cleaners are generally located directly connected to the carburetor, as it is desired to avoid long tubular connections. In some engines, particularly those of the V-type, it is feasible to draw the air from the clearest areas just back of the upper portion of the radiator. Because the air required by the carburetor is only a small fraction of that drawn in through the radiator by the fan, the presence of the carburetor inlet at any given point under the hood does not greatly affect the dust distribution.

Simple and easy methods for determining the dust concentration at various places under the hood and around the engine of a particular machine have been devised for automobiles and tractors.

Efficiency and Restriction Tests

Road tests of the efficiency of air cleaners on automobiles and trucks are difficult to make because of the many variable factors such as wind, weather conditions, and soil conditions which prevent accurate determinations. Such tests as determining the result on engine wear may be conducted but to be of value repeated tests should be made and results averaged. Laboratory tests are often made but it should be remembered that the character of the dust used is quite important. The restriction effect is measured with the aid of a manometer. Road tests are also made to determine restriction at various speeds as shown by the curve in Fig. 19. The effect of restriction on power is shown in Fig. 20. In this curve the needle valve was kept adjusted for maximum power.

The results of efficiency tests on practically all makes of air cleaners are given in Bulletin 499, University of California Experiment Station; the restriction effect is also included. The efficiencies lie within the range given in the previous installment of this paper. Efficiency and restriction effects were also determined by a few English investigators. Their tests were on a dry filter, a wet filter and a centrifugal filter of the 'cyclone' type. Mr. William Alexander, an English investigator, makes the following observation:

There are now applied to carburetor inlets vortical separators, of recent introduction and of through flow type, which give a movement to the air much nearer to the streamline motion of a "free" or Rankine vortex than is given by the usual centrifugal filter. In such modern vortical separators it is seen that the effective vortical length is the axial distance between the inlet vanes and the discharge pipe, and that practically all the air in the separating chamber is continuously displaced. Thus, as compared with the ordinary filter there are at least these advantages: (a) longer time for separation; (b) the admitted stream of air being comparatively narrow, there is a short path for particles to cross to reach the sides of the separator, and there is a uniform extraction effect on the air stream throughout the separator. Tests on a separator of the type shown in Figure 21 show an extraction of at least 99½% of any suspended flour in the entering air over a wide range of air velocities and dust concentrations and this high efficiency is maintained even though the dust box is not cleared until it is nearly full. The separator has no moving parts, and the dust box requires no oily or viscous substance inside. Incidentally, it should further be noted that another important advantage of vortical dust separation on motor vehicles is an increase of 2 to 3 miles per gallon of gas used. This is explained by

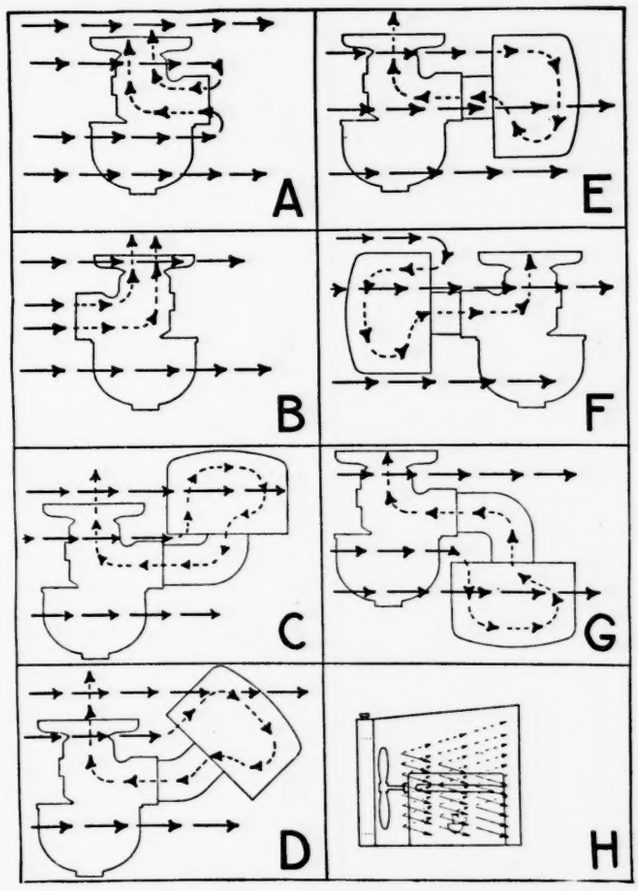


Fig. 18. Various locations for air inlets under different conditions. Carburetion shown is updraft type which has been largely displaced by downdraft carburetors. Principles of air inlet location are still fundamental.

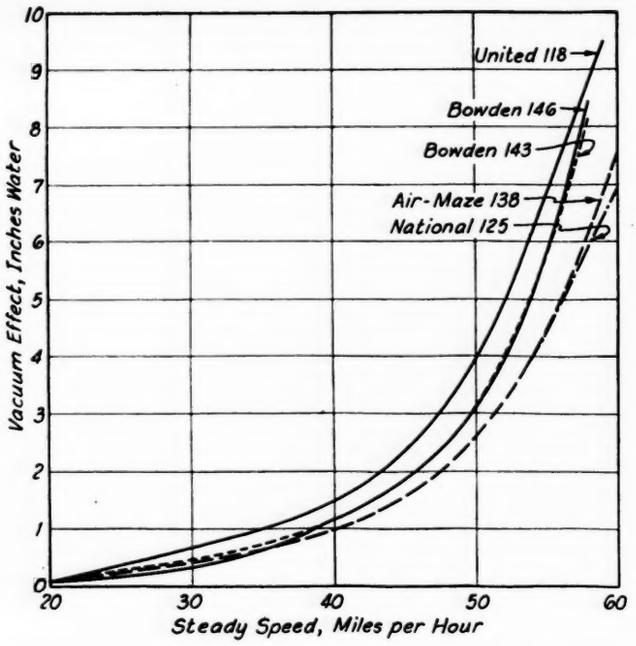


Fig. 19. Vacuum effect of air cleaners on Model A Fords. Conditions: barometer, 30 in.; air temperature, 50-56F; humidity, 55%; wind, calm.

the air retaining to a large extent its vortical motion in the induction pipe beyond the carburetor. Thus, any liquid gasoline is thrown to the sides of the intake manifold, and is given off in the form of vapor, so that the result is a better mixture in the cylinder.

Breather Cleaners

Breather air cleaners are designed to prevent the entry of dust into the crankcase with the air that, because of the piston motion, pulsates in and out of the oil filter tube and any other crankcase openings. The breather air cleaner is a valuable accessory on tractors, trucks, and automobiles in general, but is needed most on engines equipped with a crankcase ventilator. The ventilator usually draws in air through an opening near one end of the crankcase and discharges it from the other end. If the inlet opening is not well protected, the benefit to be derived by ventilation may be more than offset by damage done by the dust brought in. As in carburetor air cleaners, high efficiency without restriction is desired. Because the volumes of air to be handled are small, breather cleaners may be small and yet not offer enough restriction to cause dusty air to be sucked in or oil to be forced out through small openings in bearings or gaskets. Representative types of cleaners are shown in Figs. 22 and 23.

Adaptation and Installation

The installation and adaptation of air cleaners to engines requires the experience of a specialist who has carefully observed and investigated the various phases of actual field requirements. The device used should be so designed that the fundamental requirements of efficiency, capacity, simplicity of operation and design are adequately met.

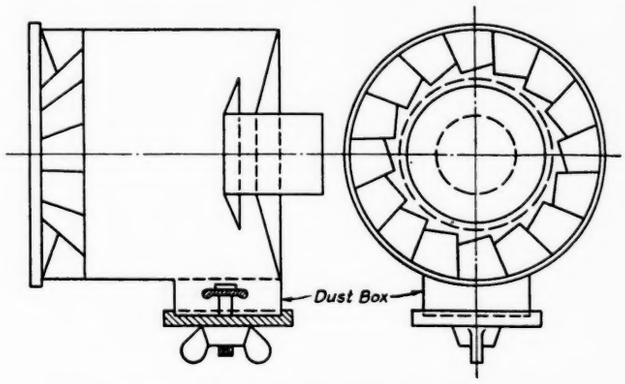


Fig. 21. Supreme Vortex dust separator.

The engine manufacturer generally does not maintain contact with actual field conditions so that frequently he fails to appreciate fully the necessity of these factors and may be influenced by low first cost or ease of installation to select a device not designed to meet most effectively the severe dust conditions encountered in the field.

The size of the cleaner is one of the primary factors affecting the installation. From the economical point of view, the efficiency, the capacity, and the size of the cleaner should be seriously considered at the time the engine is being designed. This is very important because the cleaner is depended upon, in a large degree, to protect the engine and plays a vital past in the service rendered by the engine. Probably the most important factor to consider is

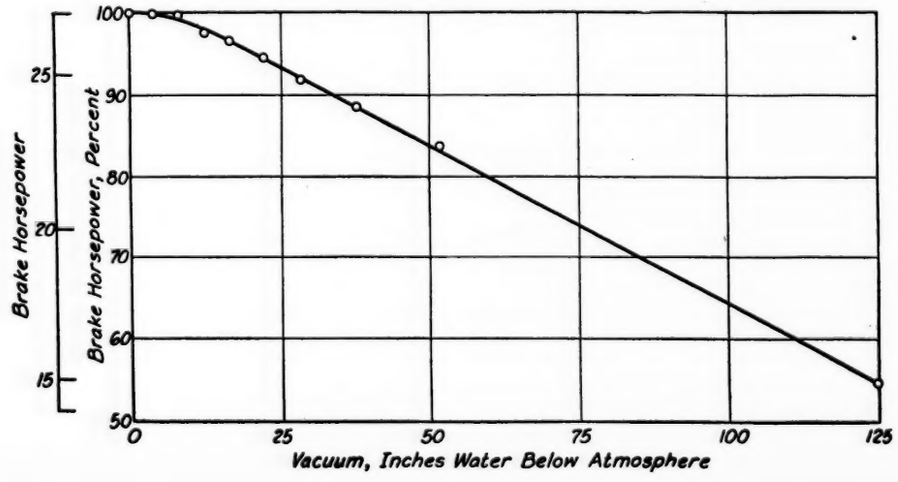


Fig. 20. Effect of air cleaner restriction or vacuum on power. The curve shows what may be expected when the cleaners are clean and the carburetor needle valve is kept adjusted for maximum power. Ordinarily such adjustment cannot be readily made, and the drop in power would be more abrupt.

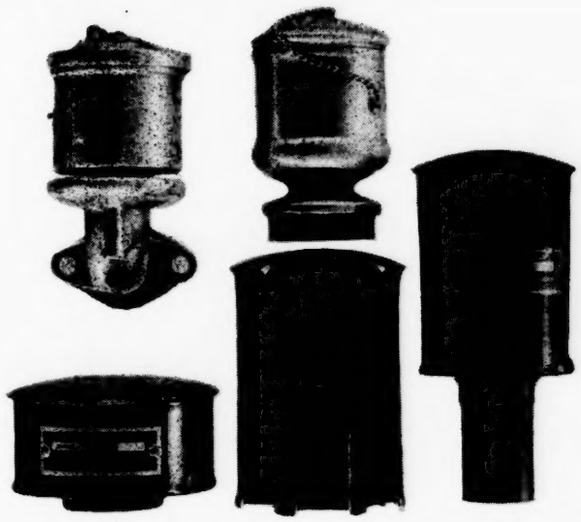


Fig. 22. Breather air cleaners of "breather caps." Both of the two kinds on the market, Vortox (lower three) and Winslow (upper two), are efficient, self-washing oily fiber types that drain to the outside and usually require very little attention. The middle Vortox is partly cut away to show the construction.

to be sure that sufficient space is provided for installation and that the cleaner should form an integral part of the machine. The adaptation of the

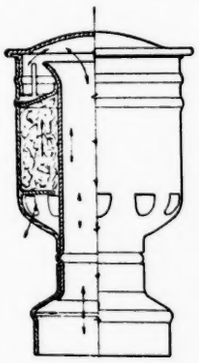


Fig. 23. Construction of Winslow breather cap. The top lifts off when oil is to be put into the crankcase. Oil may be spilled into the filter material to wash it, though usually condensed vapors from the crankcase are sufficient for this purpose.

cleaner to the engine as it is being designed is simpler than adjusting the cleaner to the machine after the development of the engine and machine has been completed. The design of the engine which incorporates the cleaner installation also gives the opportunity of making the most satisfactory connections by having the distance from the cleaner to the carburetor as short as possible and by insuring tight points.

Wartime Developments

The need for air cleaners for battlefield conditions has already been mentioned. There have been several developments under war research projects which will improve the future design of automotive and engine air cleaners. One of these developments is the Aerotec Tube. This unit is a small multicyclone device with a high efficiency. A drawing

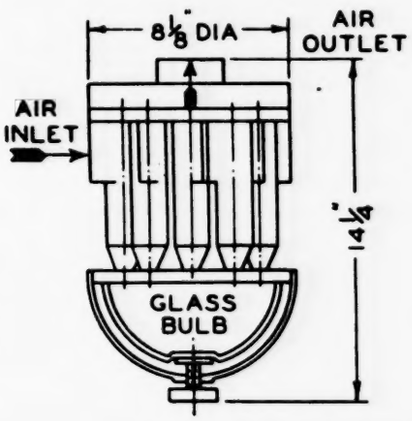


Fig. 24. Aerotec air cleaner unit, capacity 120 cfm at 2 in. of water.

of one such unit is shown in Fig. 24. It was designed primarily for tractor and small engine use. Its capacity is 120 cfm at 2 in. of water. It is cleaned by removing the glass bulb shown in Fig. 24. It was designed for engine use but can be applied to air compressors and other reciprocating machinery. This is true for all of the cleaners described.

Smoke-Free Passenger Coaches

"Every car a smoking car" is an objective of the railroads. As a part of the program of railroads to secure a better share of passenger travel, they seek to allow those who smoke to do so, but without annoyance to those who do not, and without having to provide separate equipments.

The best known method of removing more than a small percentage of particles as small as those that comprise smoke is electrostatic attraction. A unit operating on this principle—the Westinghouse Precipitron—has been in successful operation in a car on an eastern railroad for several months. This electrostatic air cleaner is shaped to lie flat overhead just inside the head-end door, and thus occupies no revenue-producing space. It consumes 75 watts. All of the fresh air makeup, about 600 cfm, and the recirculated air, 1800 cfm, is passed first through a mechanical filter that removes the large, bulky dirt and then through the precipitron to remove the fine particles.

This unit embodies the experience obtained with a passenger-car installation operated a short time before the war. It is now cleaned by connecting a hose to an outlet provided beneath the coach and running a stream of oil through the cleaner.

Another passenger-car electrostatic air cleaner is being built for use with a cyclone-type precleaner instead of the sieve type. This will make maintenance and replacement of the filter pads unnecessary.

Radiant Heating

Partial Bibliography of Articles on Radiant Heating in HEATING AND VENTILATING through 1945

In view of the many requests for information and the wide interest in radiant heating, the following bibliography is published. Unfortunately, no issues, separate sheets, or reprints of any of these articles are available, so that reference to them must be made from file copies or at libraries.

TITLE AND AUTHOR	ISSUE	PAGE
Panel System Adopted in Solution of School Ventilation Problem	April, 1927	85-86
Panel Heating in Large Commercial Building, by A. C. Blackall	Aug., 1929	76-77
Panel Heating in the British Embassy, by Alfred L. Jaros, Jr., and Richard A. Wolff		
Part I	May, 1930	82-85
Part II	June, 1930	77-81
The Theory of Radiant Heating, by T. Napier Adlam	May, 1931	56-62
Some Temperature Studies in Radiant Heated Rooms, by T. Napier Adlam	June, 1931	69-72
Radiant Heating Studied in Britain by Using Scaled Models	June, 1931	73-74
Present Methods of Heating by Thermal Radiations, by T. Napier Adlam	July, 1931	75-80
Applications of Radiant Heating, by T. Napier Adlam	Aug., 1931	65-70
Calculations for Radiant Heating, by T. Napier Adlam	Oct., 1931	62-66
Results of Tests on Radiant Heating Installations, by T. Napier Adlam	Nov., 1931	58-62
The Principles of Calculation of Low-Temperature Radiant Heating, by A. H. Barker...		
Part I	Feb., 1932	48-53
Part II	March, 1932	48-54
With a Camera on a Panel Heating Installation	April, 1932	33-36
Panel Heating Tests Being Conducted in Great Britain	Sept., 1932	26
Radiant Heating Today, by T. Napier Adlam	July, 1936	22-25
Radiant Heat Used in Modern New England Home	March, 1941	28-29
Radiant Heating Reference Section, by Joseph F. Kern	March, 1941	35-66
Floor Temperatures for Radiant Heating	April, 1941	27
Radiant Heating by Convection, by Richard Bridley and Alwin Ottum	July, 1941	40-43
Radiant Heat for Army Air Force Airplane Hangars, by Elmo Hall	Sept., 1943	51-54
Weather-Controlled Residential Radiant Heating Systems, by Paul E. Frederick	Oct., 1943	34-37
Radiant Heat Installed in Chapels at Naval Air Station, by F. E. Markel	Feb., 1944	82-84
Heating the Post-War House (reference to panel heating on page 75) by Robert Thulman	March, 1944	67-83
Some Notes on Radiant Heating, by T. W. Reynolds	June, 1944	81
Farewell to Snow Shoveling, by T. N. Adlam	Aug., 1944	53-54
Radiant Heat, Air Sanitation Hold Post-War Promise (Survey)	Aug., 1944	65-67
Radiant Heating Panel Calculations, by Irwin Jalonack	Dec., 1944	57-60
Answers to Radiant Heating Questions, by Elmo Hall	Jan., 1945	57-60
Locating the Panel in Radiant Heating Systems, by R. G. Vanderweil	April, 1945	63-67
Calculations for Radiant Heating an Industrial Building	May, 1945	64-66
Temperature Distribution and Tube Expansion in Radiant Heating Panels, by R. G. Vanderweil	June, 1945	69-74
Some Experience Data on Snow Melting by Underground Pipes, by T. N. Adlam	June, 1945	87-89
Radiant Wall System for Stratoliners	July, 1945	62-64
Panel Layout and Coil Installation for Radiant Heating System, by R. G. Vanderweil	July, 1945	90-95
Piping and System Control for Radiant Heating Systems, by R. G. Vanderweil	Aug., 1945	78-81
Radiant Wall Heating (for planes)	Aug., 1945	84-85
Heat Flow in Panel-Heated Rooms, by R. G. Vanderweil	Oct., 1945	102-110

NEWS OF THE MONTH

CONSTRUCTION

Private construction rises in response to capital inducements.

• **UP.**—In spite of much talk of bottlenecks, price restrictions, and labor uncertainty, there has been a contraseasonal upturn in new construction during the past two or three months in response, chiefly, to a sharp rise in private residential building. While returns are still incomplete, indications are that total new construction in 1945 was nearer $4.7 billion than the $4.5 billion previously estimated.

Wholesale prices of construction materials, too, were rising in 1945 and by October had reached the highest level since 1920 and were 30.7% above the 1939 average.

• **INFLUENCE.**—Not the least potent factor influencing construction's rise has been the lifting of some state regulations governing the real estate expenditures of insurance companies. Prominent examples of this trend are seen in Massachusetts and New Jersey. A law passed at the last session of the Massachusetts legislature for the first time permits insurance companies domiciled in that state to invest in housing. Similarly, last spring the New Jersey legislature allowed that state's insurance companies to invest 5% of gross assets in real estate. Previously, N. J. permitted no insurance company to invest in income property.

• **INSURANCE MONEY.**—Encouraged by Metropolitan Life's success with the Parkchester development and the lifting of legal restrictions in its home state of New Jersey, the five-billion-dollar Prudential Life Insurance Co. has tentative plans for a $250 million investment in real estate. While middle class housing will be emphasized, the greater part of Prudential's over-all building expenditure probably will be in office and store buildings.

In Massachusetts the John Hancock Life Insurance Co. is reported to be planning a $12 million garden city in Brookline, Mass. Hancock, however, is planning one and two-family residences for its 130-acre site while other companies are concentrating on multi-unit dwellings. With new legal freedom, it is expected that other Massachusetts domiciled insurance companies may turn to residential real estate as an investment.

Signs of insurance company interest in real estate are amplified by Metropolitan's part in three more housing projects in the New York area in addition to Parkchester and by Equitable's $49 million real estate investment, much of which has gone into the Clinton Hill project in Brooklyn. Connecticut Mutual, too, had the highest bid on the plot of ground beneath the much-auctioned tower section of Chicago's Morrison Hotel. Should a sizeable percentage of the $49 billion life insurance assets in the United States be invested in residential real estate the results should be impressive.

• **HOTELS.**—Indicative of the state of the Nation's existing structures are the results of a recent survey by the American Hotel Association which, patterned after the Gallup system, sought to determine the itemized needs of U. S. hotels with respect to rehabilitation, re-equipment, modernization, and additions to existing structures. The cost of these itemized needs for 12,868 hotels came up to the impressive total of $1,441,159,617.

Some items on AHA's list are as follows: $76 million for air conditioning; $25 million for refrigeration; $22 million for plumbing; $14 million for boiler rooms; $3 million for power plants; $7 million for steam distribution; and $4 billion for ventilation.

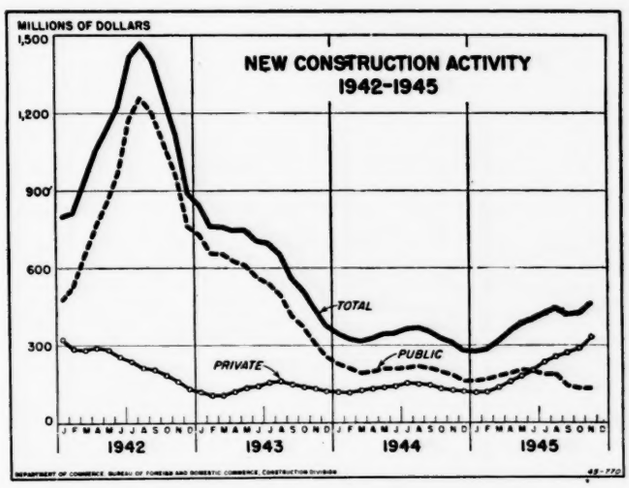
• **UNIVERSITIES.**—Mechanical refrigeration and air conditioning will play an important part in the postwar building programs of most of the nation's leading universities and colleges, according to the Refrigeration Equipment Manufacturers Association.

A REMA survey, covering 100 educational institutions, revealed that numerous schools are planning air conditioning of classrooms and laboratories in new buildings. Other schools plan air conditioned departments and refrigerated rooms for special research purposes.

Included among the schools with postwar building plans is the Georgia School of Technology which will start work on a $1,900,000 building program as soon as labor and materials are available. The program includes a $900,000 classroom building and a $1,000,000 administration building, both completely air conditioned.

The University of Kansas, which also is planning an extensive expansion program, advised REMA that all of its new buildings will be air conditioned.

The California legislature has approved an appropriation of $500,000 for the erection of a new building in


MILLIONS OF DOLLARS
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NEW CONSTRUCTION ACTIVITY
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Monthly figures on construction for past 4 years as compiled by U. S. Commerce Dept.

the College of Agriculture of the University of California. Extensive equipment for the study of frozen foods will be included in the new building. In addition, the university expects to expand its facilities for instruction and research in air conditioning.

Cornell University and the Massachusetts Institute of Technology reported they are adding new apparatus and enlarging their laboratories for mechanical refrigeration, air conditioning and food courses.

A new agricultural science building is being planned by the Vermont Agricultural Experiment Station according to that institution's report to REMA. The new building will include facilities for quick freezing and constant temperature rooms for research work.

The Department of Mechanical Engineering at the University of Illinois will have a new mechanical engineering building in the near future which will include a low temperature laboratory for instruction and research in problems involving sub-zero temperatures.

In addition, the College of Medicine of the University of Illinois has an appropriation for a large addition to its research and educational hospital, including six special air conditioned laboratories for experiments on the reaction of the human body in temperatures ranging from 40 degrees above zero to 120 degrees above zero. Another laboratory will provide temperatures ranging

from 20 degrees below zero to 120 degrees above for similar experiments.

Extensive experiments in home air conditioning are being planned by Purdue University which is expanding its laboratory facilities and adding new air conditioning apparatus for research and instruction.

The University of Michigan reported that its tentative plans call for a considerable increase in refrigerating and air conditioning equipment, including coolers, fans, pumps and compressors.

Other universities and colleges which reported expansion programs for their courses in mechanical refrigeration, air conditioning and frozen foods include Princeton University, College of the City of New York, University of Colorado, University of Idaho, University of Wyoming, Texas Christian University, Tuskegee Institute and Tulane University.

FORD EXPANDS

Assembly plant, office building, and power plant group to speed Ford car deliveries.

• **PLANT.**—A new assembly plant for the Ford Motor Co., at St. Louis, Mo., as conceived on the design boards of Albert Kahn Associated Architects and Engineers, Inc., comprises an assembly building, to which is joined a separate office building, separate power house, related service structures, and test track. The site fronts on U. S. Highway 66 and backs up to Cold Water Creek just beyond the St. Louis city limits in the vicinity of the municipal airport.

All buildings are of structural steel, with steel sash, and enclosing walls of brick and gunite. The center and higher portion of the office building containing the entrance lobby, fan rooms, etc., is faced with limestone.

The assembly building is 520 by 1,480 ft, with the production area one-story high. A monitorless roof of insulated cement tile support eight fan rooms for summer and winter ventilation, as well as transformer and switch rooms.

• **FOR THE WORKERS.**—Across the building, midway of its length, is a second story portion 120 by 450 ft exclusively for employee facilities. To the north of the building, and extending to the property line is a parking area with a capacity of 650 employee cars. Public bus transportation facilities are also provided in an arrangement which prevents cross-traffic. From the parking lot area, stairways and overpass, bridging the factory driveway, give access to the second story portion of the assembly plant. Here are grouped lockers, showers, toilets, cafeteria, kitchen, first aid, and similar facilities, with stairways to the main assembly floor.

• **ASSEMBLY.**—The assembly line runs the length of the north section of the plant. Incoming parts are received in the railroad track bay along the south side of the building and are processed as they move across the floor to the proper station on the line. Finished cars move on to a test track off the northwest section of the plant, with adjacent shipping and drive-away facilities. In the southwest area of the plant is a service parts depot.

• **OFFICE.**—West of the main plant is the one-story office building 230 by 310 ft, housing general and executive offices, cafeteria for visitors and office workers, display room combined with the lobby, and conference room for service instruction and similar functions. A garage, 65 by 250 ft, connects office and plant.

The power house, 100 by 120 ft, stands off the south side of the main plant. Three oil-fired boilers, each with a capacity of 60,000 lb of steam per hour, provide steam for heating all buildings and for process work. Also in the boiler house are three rotary-type air compressors, each with a capacity of 1,600 cfm. Large fuel oil tanks, surrounded by a protecting dyke, are provided adjacent to the boiler house and convenient to the railway spur. In addition, an oil house contains storage facilities for various kinds of lubricants, paints, and mixing equipment. Provision is made in the original plan for future expansion when desired, notably in the boiler house and on the east end of the main assembly plant. The Patrick Warren Construction Co. is the general contractor for this project.

REFRIGERATION

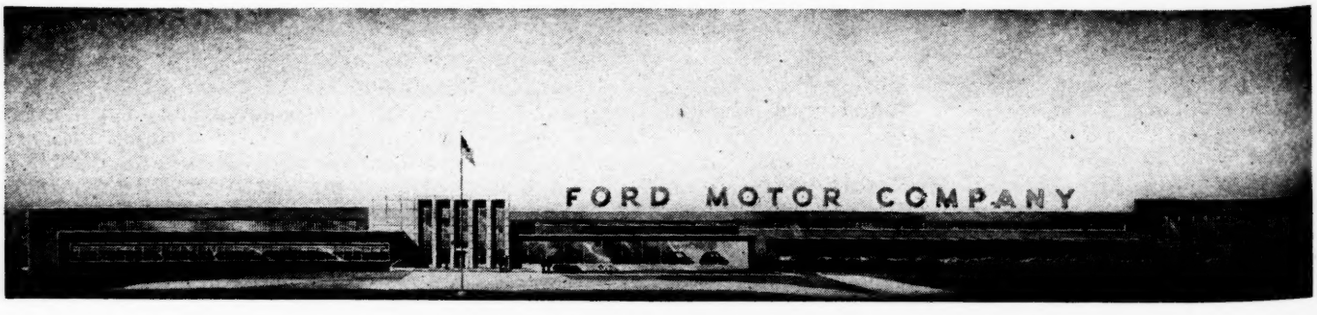
Refrigeration Research Foundation lists various grants.

• **RESEARCH.**—Twenty grants, totalling $47,300 have been made available to 18 college scientists and one government expert by the Refrigeration Research Foundation, for new or continuing investigation of various phases of food preservation. Largest of the grants ($5,000) was to Dr. B. E. Proctor, professor of food technology at the Massachusetts Institute of Technology. Dr. Proctor's work is in frozen pre-cooked foods.

• **AIR.**—Many of the projects supported by the foundation have to do with problems in controlled atmosphere. Dr. H. B. Jennings, at Northwestern University, will conduct research on low temperature psychrometry, while Dr. W. L. Mallmann, at Michigan State College, will make a study of refrigeration methods as they relate to maintenance of desired relative humidities.

Dr. Mallmann was also named in a grant supporting a project involving a study of aerosols to explore their application to refrigerated warehouses.

At Cornell University, Dr. R. M. Smock, professor of pomology, will work on a study of odor removal in refrigerated storage. Another project under the direction of Dr. Smock will be the study of the methods of



Front elevation of the Ford Motor Co. plant designed for St. Louis, Mo.

removal of volatile materials produced by stored products in refrigerated rooms.

• **HEAT TRANSFER.**—Dr. Carl F. Kayan, Columbia University, was granted $2,000 to study the heat transfer aspects of refrigerated warehouse packaged goods. Along similar lines, Dr. L. H. Bartlett, at the University of Texas, has as his project the determination of the thermal characteristics of refrigerated foods.

Totalling 20 grants in all, most of the projects supported by the foundation have to do with storage and preservation of food. The foundation was formed in 1943 by the Refrigerated Warehouse Industry and has as its objective the development of the science and art of refrigeration.

MATERIALS

Materials affecting building industries under surveillance.

• **DISTRIBUTION.**—Reminiscent of wartime efforts to spread available materials among most pressing needs is the priority system for scarce building materials which went into effect January 15 and will be administered by the 71 field offices of the Federal Housing Administration.

Purpose of the scheme is to divert materials to and speed construction of housing costing under $10,000 or renting for less than $80 to be occupied by veterans. Application forms for "HH" housing" priority are available to builders at FHA district offices, to whom the task of processing has been delegated by the Civilian Production Administration.

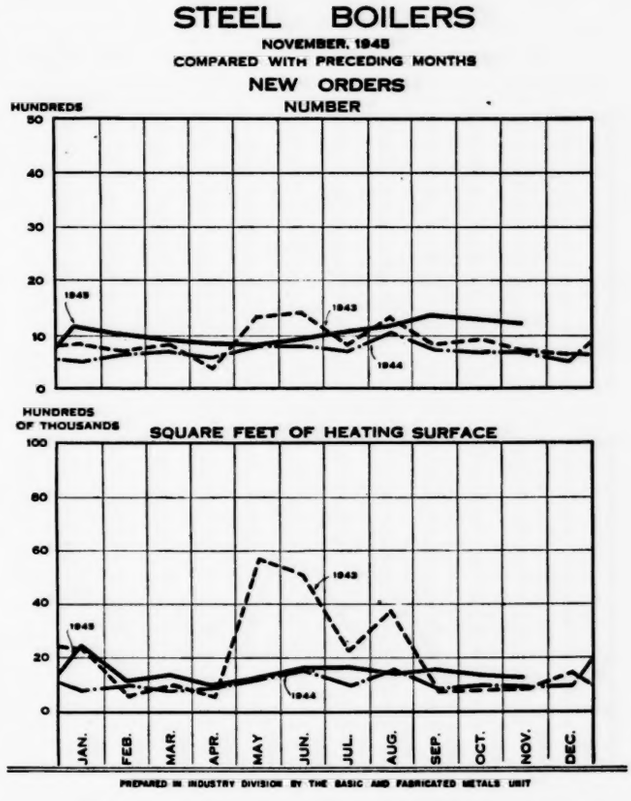
Instrument of the system is Priorities Regulation 33 which specifies not only the end use and ceiling for the finished housing but also lists materials to which priorities will apply. These are: Common and face brick, clay sewer pipe, structural tile, gypsum lath, cast iron soil pipe and fittings, cast iron radiation, bathtubs, lumber and millwork.

• **PRICES.**—Attempts to give construction of veterans' housing an additional shot in the arm are evidenced in price concessions by OPA on various items. The following list of headings from recent OPA releases are indicative: Plumbing manufacturers given 8% increase on fixtures; Raise most West Coast logs $1.50 per thousand feet; Hemlock and hardwood given increase in Lake States; Give increase in sewer pipe in area of southwest; Increase glazed brick, facing tile $2.50 per 1000; Simultaneous price and wage increase announced for cast iron soil pipe; Clay drain tile given increase; Heat absorbing glass given 2½% increase; Gas and petroleum fired furnaces given 12½% increase; Oil burner manufacturers given 9% increase.

• **PRODUCTION.**—With the exception of lumber products, which are still tied up with labor and equipment difficulties, most items on the scarce list are showing increasing production rates. Cast iron soil pipe, for instance, is at a 12 month high and there is some evidence of a return of labor to the industry and of foundry reopenings (H&V:1:46:p.101).

Boiler and radiator manufacturers reported to *The New York Times* that the supply for next winter's season would "not be too bad." They warn, however, that it will be at least a year before equipment can be selected from stock. An over-all survey of the heating supply situation is reviewed on page 63.

• **STANDARDS.**—Two proposals have been sent out to producers, distributors, and users by the National Bureau of Standards. One of these is a proposed simplified practice recommendation for copper water tube and copper and brass pipe. The other proposal is a recommended revision of the commercial standard for pipe nipples; brass, copper, steel, and wrought iron. Since signed acceptances of the latter proposal have been received



Bureau of Census figures on steel boilers.

from what is estimated to be a majority of manufacturers the standard, identified as CS5-46, may be considered effective for new production beginning February 15. Copies of either proposal may be obtained from the National Bureau of Standards, Washington 25, D. C.

DISTILLATION

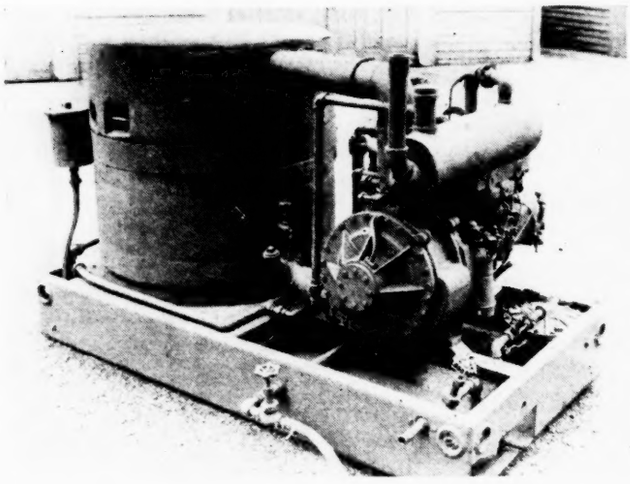
New compressor method supplies fresh water from sea water.

• **INVENTOR.**—Compression distillation, a new method of distilling fresh water from sea water, was accomplished by R. V. Kleinschmidt, U.S.N.R., now associated with Arthur D. Little, Inc., a Cambridge, Mass., research firm. Commodore Kleinschmidt did the early work on this wartime project while with this company. Machines for the work were made by E. B. Badger & Sons Co., Boston.

R. V. Kleinschmidt

Enough drinkable water was produced by this means to take care of ship personnel and landing parties during the war. The process shows great promise for use on passenger ships and for industry.

• **MACHINE.**—The new method involves distillation by mechanical energy instead of by externally applied heat, used in all other types of distillation and evaporation. Some 175 pounds of distilled water are produced for each pound of fuel used. Compression distillation de-



Most recently developed compression distillation unit. This gasoline-engine driven model will produce 1,800 gallons of distilled water daily from sea-water.

pends upon mechanically compressing steam or other vapor leaving the evaporation compartment of the still, thereby raising the temperature of the steam a few degrees. At the higher pressure, the steam condenses at a temperature somewhat higher than the boiling point of evaporating raw water, so that heat can flow from the condensing steam to the raw water and boil it. Efficient provision for reducing heat loss to the atmosphere and recovering heat from the distillate and concentrate carrying out wastes as they cool down to room temperature, completes the system. Only 1/15 of the energy of the single effect evaporator is used by this method, which is far more simple to operate than a multiple-effect unit.

• **USES.**—Fuel economy of the system is particularly valuable where waste steam is not available from other operations, making it available on small cargo vessels and fishing boats using gasoline or diesel oil fuel. It is applicable to liquids other than water, and in situations where the concentrated residue is desired rather than the distillate, such as condensed milk or maple syrup and many others. With wartime use to one side, the Kleinschmidt system is now available to industry.

COMBUSTION

Industries concerned with the combustion of coal gird for combat against smoke.

• **COMMITTEE.**—Revitalized recently was the Coal Producers Committee for Smoke Abatement (H&V: 11:45:p.102), an organization financed by coal producers and coal-hauling railroads for the purpose of aiding municipalities in abating that part of the atmospheric pollution caused by the inefficient combustion of coal.

• **BITUMINOUS.**—Through Bituminous Coal Research, Inc., laboratory attention has been given to the problem of smokeless combustion of bituminous coal. For instance, in a speech by C. B. Graves, vice-chairman of the Coal Producers Committee, BCR is reported to have developed a hand-fired magazine type stove which is smokeless under any condition of operation and with any coal. A second development of BCR is in residence stokers, which are completely automatic. Railroads are installing over-fire steam and air jets developed by BCR.

• **ANTHRACITE.**—A step in the direction of coordinated effort in the promotion of efficient coal combustion was made in the consolidation of the activities of Anthracite Institute and The Anthracite Industries, Inc., under one organization to be known as Anthracite Institute. Frank W. Earnest, Jr., formerly executive director of Anthracite Institute and president of the Anthracite Industries, Inc., was elected president of Anthracite Institute.

This consolidation brings together anthracite organizations functioning on matters pertaining both to product and research. One line of activities by the new organization is evidenced in the inauguration in the School District of Philadelphia, of a Stoker Training Class at Dobbins Vocational School. The course is to be given by John Stalker, member of the engineering staff of the Anthracite Industries laboratory, and will consist of two evening lectures a week and will continue for about 12 weeks. It is intended for heating service men, employees of coal dealers, and heating contractors and other interested persons. Purpose of the course is to train newcomers in the operation of stokers and combustion of coal.

• **INTEREST.**—The urgency of smoke control is reflected in various activities of municipal and city agencies throughout the nation. The Los Angeles County Civil Service Commission has announced a nation-wide examination for air pollution inspectors. Persons appointed as a result of this examination will work in the recently created Department of Air Pollution Control, organized to alleviate conditions arising out of rapid industrialization of the Los Angeles area. In addition, Los Angeles City has been doing spot research on atmospheric conditions. Other cities interested actively in smoke abatement are Cincinnati, Baltimore, New York, Boston, Cleveland, Indianapolis, Louisville, and others (H&V:11:45:p.102).

WEST COAST

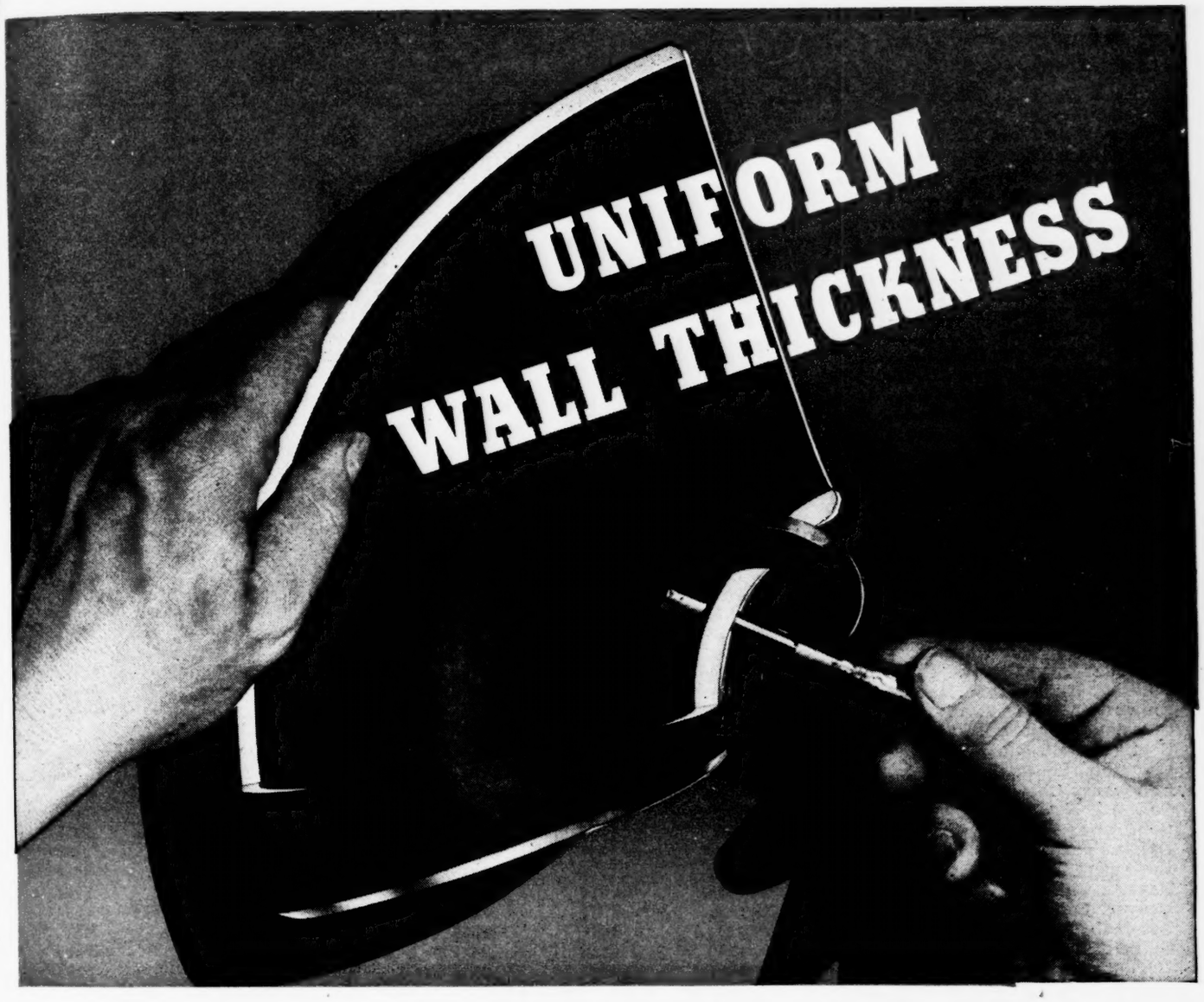
Education and legislation take up slack in design fields on Pacific Coast area.

• **COURSE.**—An 18-week night-school course dealing with the design, function and installation of mechanical equipment and systems in modern buildings, including all phases of heating, refrigeration, air conditioning, ventilation, plumbing, electrical work, acoustics and illumination, was initiated on January 17, at Los Angeles as part of a program in architectural subjects, by the engineering extension division of the University of California at Los Angeles, in co-operation with Southern California Chapter, American Institute of Architects.

• **LICENSING.**—Intended to make it more difficult for irresponsible and incompetent contractors to obtain licenses, the California State License Board, effective January 1, revised and amended its Rule 31 on provisions for endorsements of applications.

Under the revision, applicants must submit three signed references on a form prescribed by the State Registrar of Licenses, from contractors, architects or engineers who hold licenses from either the California Contractors License Board, the State Architectural Examiner or the State Board of Registration for Civil Engineers. Three letters from licensed contractors in the same classification as the one the applicant applies for must also be supplied under the new ruling.

• **HOMES.**—The Home Planning Institute of Los Angeles, a non-profit organization sponsored by the Los Angeles Chamber of Commerce, Los Angeles Board of Education and allied building trades, opened its second annual series of night school classes on January 22, with courses patterned after the Chicago Round Table.



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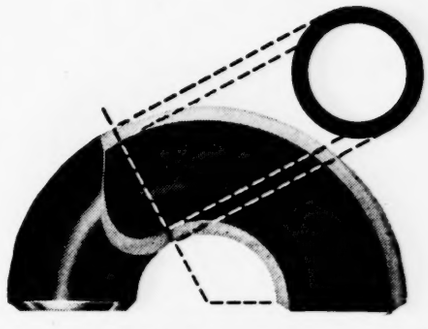

Quality control and inspection assure uniform wall thickness within ASA tolerances at all points. Full circularity is maintained throughout.

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Degree-Days for December, 1945

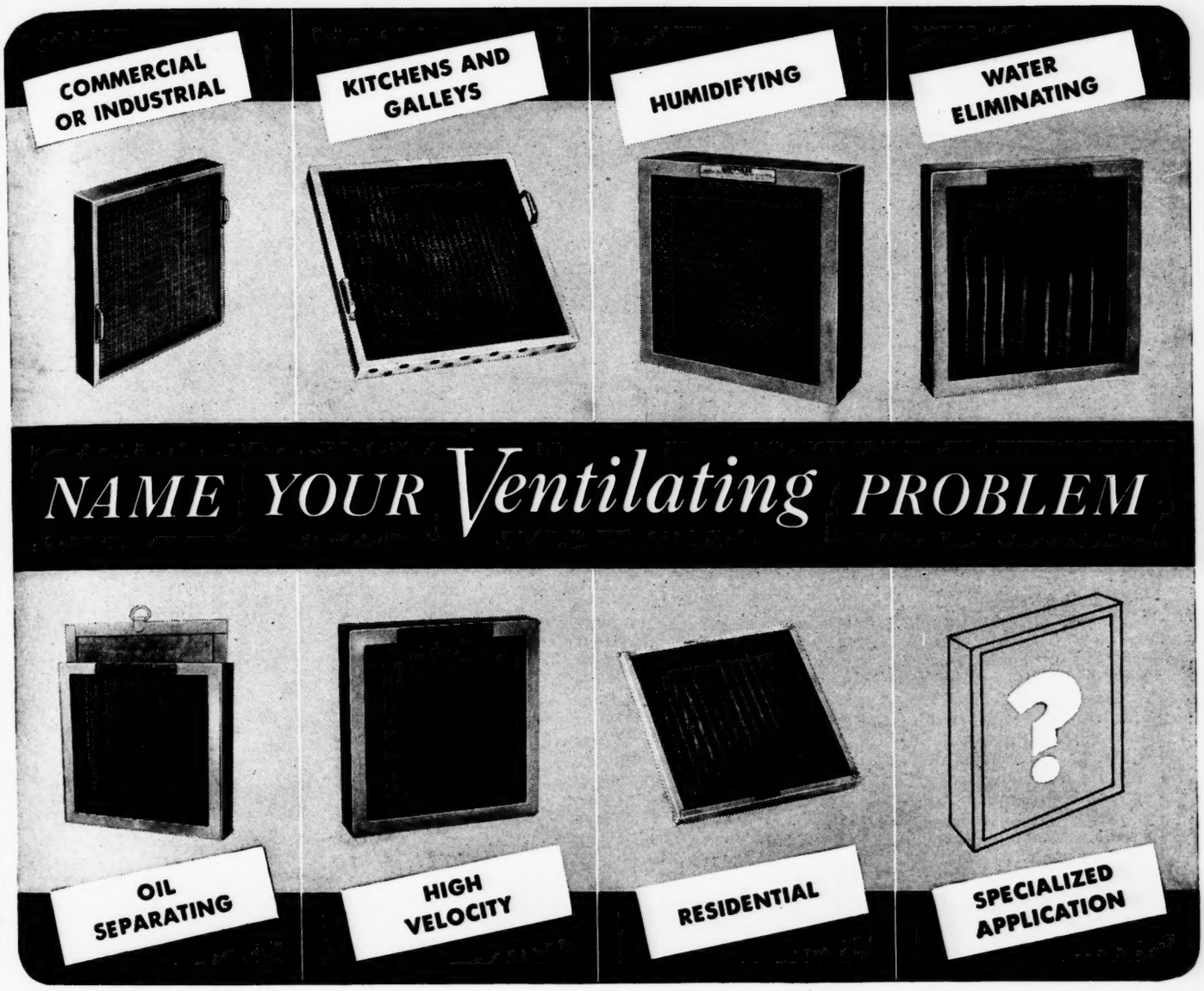
HEATING AND VENTILATING'S 19TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	DECEMBER			CUMULATIVE, SEPTEMBER 1 TO DECEMBER 31			HEATING SEASON[1]
	1945	1944	NORMAL	1945	1944	NORMAL	NORMAL
Abilene, Texas	674	689	592	1063	1055	925	2061
Albany, New York	1354	1277	1147	2726	2624	2439	6580
Albuquerque, New Mexico	982	888	924	1833	1769	1827	4298
Alpena, Michigan	1302	1298	1247	2959	2844	2951	8299*
Anaconda, Montana	1274	1331	1238	3196	3133	3171	8357**
Asheville, North Carolina	977	904	837	1811	1789	1689	4232
Atlanta, Georgia	829	754	639	1323	1314	1131	2890
Atlantic City, New Jersey	981	925	893	1694	1765	1735	5176
Augusta, Georgia	704	643	549	1046	1041	886	2161
Baker, Oregon	1151	1173	1156	2815	2639	2815	7163
Baltimore, Maryland	980	936	874	1669	1724	1664	4533
Billings, Montana	1278	1189	1194	2892	2611	2816	7119
Binghamton, New York	1263	1233	1156	2551	2607	2515	6808
Birmingham, Alabama	798	681	595	1279	1160	913	2352
Bismarck, North Dakota	1740	1464	1553	3873	3315	3514	9192
Block Island, Rhode Island	1026	955	884	1936	1940	1736	5788
Boise, Idaho	1056	1114	1011	2352	2252	2285	5552
Boston, Massachusetts	1133	1062	1026	2156	2172	2130	6045
Bozeman, Montana	1331	1357	1293	3253	3076	3286	8521**
Buffalo, New York	1277	1228	1104	2599	2509	2372	6822
Burlington, Vermont	1417	1410	1287	2975	2994	2773	7514
Butte, Montana	1377	1394	1261	3479	3329	3183	8272
Cairo, Illinois	983	967	822	1660	1602	1499	3909
Canton, New York	1483	1489	1342	3127	3134	2994	8020
Charles City, Iowa	1550	1461	1390	3194	2811	2895	7588
Charleston, South Carolina	571	577	425	816	870	632	1769
Charlotte, North Carolina	823	787	679	1331	1394	1220	3120
Chattanooga, Tennessee	907	825	694	1516	1526	1225	3118
Cheyenne, Wyoming	1217	1171	1144	2875	2760	2889	7466
Chicago, Illinois	1249	1336	1119	2424	2406	1919	5957
Cincinnati, Ohio	1131	1110	927	2025	2053	1796	4684
Cleveland, Ohio	1190	1167	1060	2280	2249	2185	6155
Columbia, Missouri	1195	1171	985	2136	1987	1896	4922
Columbia, South Carolina	728	682	561	1086	1119	916	2364
Columbus, Ohio	1192	1155	1017	2193	2160	2020	5398
Concord, New Hampshire	1391	1329	1234	2923	2888	2732	7353
Concordia, Kansas	1255	1099	1050	2277	2007	2019	5315
Dallas, Texas	668	648	567	967	937	870	2256
Davenport, Iowa	1373	1327	1175	2658	2354	2333	6289
Dayton, Ohio	1275	1219	1014	2406	2300	1947	5264
Denver, Colorado	1006	1001	1017	2261	2082	2276	5874
Des Moines, Iowa	1414	1344	1215	2658	2396	2370	6384
Detroit, Michigan	1250	1250	1113	2491	2405	2332	6490
Devils Lake, North Dakota	1917	1602	1710	4339	3545	3871	9970
Dodge City, Kansas	1120	1042	1004	2056	1951	1952	5035
Dubuque, Iowa	1419	1377	1243	2853	2564	2534	6790
Duluth, Minnesota	1652	1545	1519	3787	3304	3489	9443
Eastport, Maine	1266	1209	1228	2856	2745	2890	8520**
Elkins, West Virginia	1198	1147	1035	2400	2488	2217	5697
El Paso, Texas	607	629	617	1029	1090	1038	2428
Ely, Nevada	1254	1226	—	3069	3050	—	—
Erie, Pennsylvania	1162	1124	1039	2256	2117	2164	6273
Escanaba, Michigan	1379	1390	1344	3195	2983	3138	8771*
Evansville, Indiana	1113	1084	862	1984	1936	1545	4244
Fort Smith, Arkansas	889	835	707	1421	1255	1177	3147
Fort Wayne, Indiana	1314	1334	1138	2621	2578	2211	5925
Fort Worth, Texas	672	647	574	964	931	826	2148
Fresno, California	538	543	577	925	970	911	2334
Galveston, Texas	327	308	270	394	422	330	1016
Grand Junction, Colorado	1226	1016	1162	2387	1935	2278	5548
Grand Rapids, Michigan	1229	1219	1147	2582	2430	2397	6535
Green Bay, Wisconsin	1466	1426	1324	3166	2825	2882	7825
Greensboro, North Carolina	963	912	760	1683	1727	1395	3529
Greenville, South Carolina	868	796	738	1428	1417	1334	3380
Harrisburg, Pennsylvania	1117	1097	992	2132	2137	1981	5375
Hartford, Connecticut	1270	1186	1060	2457	2444	2157	6036
Hatteras, North Carolina	626	644	493	897	1045	727	2571
Havre, Montana	1528	1396	1383	3523	3196	3314	8700
Helena, Montana	1352	1526	1245	3216	3326	3058	7898
Houston, Texas	396	380	335	504	535	449	1157
Huron, South Dakota	1632	1358	1431	3372	2919	3085	8004
Indianapolis, Indiana	1205	1178	1017	2220	2129	2002	5298
Jackson, Miss.	646	594	—	978	935	—	—
Kansas City, Missouri	1216	1142	1008	2097	1866	1866	4956
Kewanee, Illinois	1318	1285	1118	2456	2270	2311	6139
Knoxville, Tennessee	929	863	781	1585	1627	1483	3670
La Crosse, Wisconsin	1568	1384	1311	3285	2636	2778	7322
Lander, Wyoming	1472	1678	1419	3369	3637	3075	7947

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill.; Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, Box 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table Concluded on page 108]



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Degree-Days for December, 1945 (Concluded)

HEATING AND VENTILATING'S 19TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

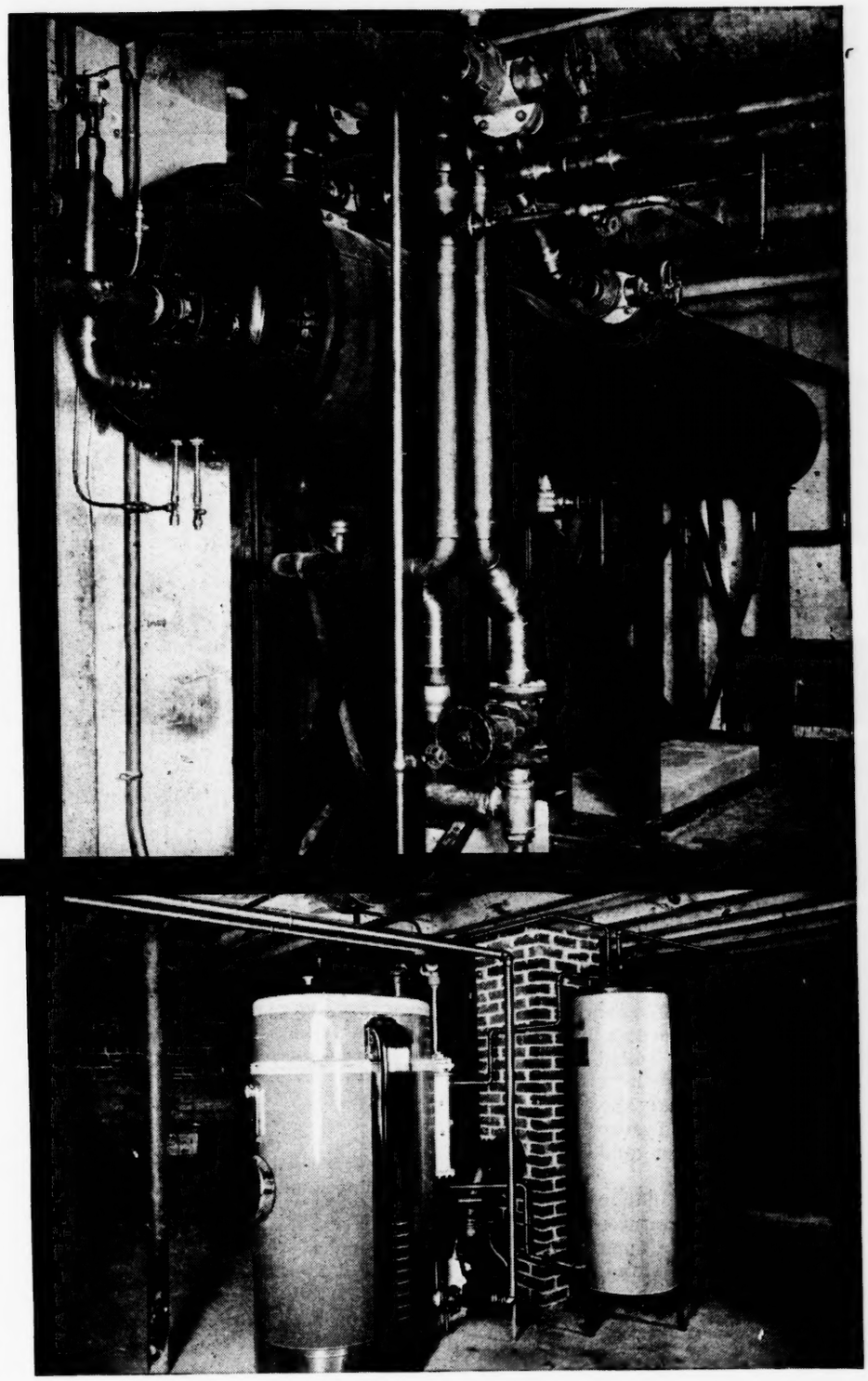
CITY	DECEMBER			CUMULATIVE, SEPTEMBER 1 TO DECEMBER 31			HEATING SEASON[1]
	1945	1944	NORMAL	1945	1944	NORMAL	NORMAL
Lansing, Michigan	1303	1335	1209	2786	2757	2665	7048
Lewiston, Maine	1394	1343	1295	3041	2920	2837	7707
Lincoln, Nebraska	1333	1194	1132	2428	2225	2201	5999
Little Rock, Arkansas	838	834	651	1353	1297	1079	2811
Livingston, Montana	1196	1233	1117	2899	2924	2731	7205
Los Angeles, California	246	164	301	413	385	424	1504
Louisville, Kentucky	1031	1023	849	1794	1805	1587	4180
Lynchburg, Virginia	1004	973	800	1781	1878	1557	3980
Macon, Georgia	711	615	567	1086	1059	897	2201
Madison, Wisconsin	1465	1436	1321	3037	2724	2758	7429
Marquette, Michigan	1359	1347	1302	3195	2930	3054	8693*
Memphis, Tennessee	862	845	663	1420	1389	1127	2950
Meridian, Mississippi	662	612	549	995	1030	883	2160
Milwaukee, Wisconsin	1349	1403	1221	2752	2624	2601	7245
Minneapolis, Minnesota	1602	1417	1404	3332	2801	2941	7850
Modena, Utah	1163	1108	1168	2570	2533	2672	6562
Montgomery, Alabama	657	504	496	965	826	769	1884
Nantucket, Massachusetts	1015	928	905	1925	1913	1912	5957
Nashville, Tennessee	953	896	744	1632	1599	1363	3507
New Haven, Connecticut	1182	1101	1017	2273	2261	2109	5895
New Orleans, Louisiana	404	314	301	510	441	403	1024
New York, New York	1057	1010	955	1896	1899	1849	5347
†Nome, Alaska	1679	1492	1509	3479	3322	3379	14580**
Norfolk, Virginia	819	779	685	1264	1335	1195	3350
North Head, Washington	639	608	654	1904	1570	1785	5452**
North Platte, Nebraska	1328	1155	1173	2578	2406	2486	6366
Oakland, California	468	446	496	1056	1029	1099	3143**
Oklahoma City, Oklahoma	903	851	815	1433	1340	1379	3613
Omaha, Nebraska	1416	1289	1175	2602	2347	2284	6131
Oswego, New York	1255	1218	1138	2565	2558	2494	7088
Parkersburg, West Virginia	1091	1091	921	1989	2099	1830	4775
Peoria, Illinois	1346	1328	1150	2632	2396	2323	6109
Philadelphia, Pennsylvania	1026	973	905	1798	1788	1735	4855
Phoenix, Arizona	430	340	425	621	574	581	1405
Pittsburgh, Pennsylvania	1110	1092	967	2100	2079	1949	5235
Pocatello, Idaho	1237	1284	1181	2835	2860	2649	6655
Portland, Maine	1328	1277	1159	2918	2817	2605	7218
Portland, Oregon	699	760	729	2643	1578	1724	4469
Providence, Rhode Island	1122	1048	1026	2113	2083	2130	6015
Pueblo, Colorado	1175	1024	1029	2362	2183	2164	5514
Raleigh, North Carolina	872	834	694	1385	1483	1253	3234
Rapid City, South Dakota	1326	1220	1172	2911	2714	2701	7118
Reading, Pennsylvania	1092	1049	1001	2023	2028	2014	5389
Red Bluff, California	573	503	—	1050	955	—	—
Reno, Nevada	977	978	973	2266	2310	2284	5892
Richmond, Virginia	945	865	763	1564	1577	1380	3695
Rochester, New York	1304	1294	1125	2644	2645	2414	6732
Roseburg, Oregon	618	727	719	1546	1579	1741	4428
Roswell, New Mexico	742	825	808	1372	1467	1510	3484
Sacramento, California	547	532	574	954	969	996	2653
St. Joseph, Missouri	1268	1194	1079	2270	2016	1960	5161
St. Louis, Missouri	1130	1106	936	1976	1848	1738	4585
Salt Lake City, Utah	1091	994	1020	2383	2032	2149	5555
San Antonio, Texas	444	499	347	624	735	473	1202
San Diego, California	239	208	288	412	396	487	1645
Sandusky, Ohio	1215	1208	1063	2283	2265	2142	6208
San Francisco, California	380	337	428	881	886	949	3264**
Sault Ste. Marie, Michigan	1495	1420	1370	3494	3272	3247	9285**
Savannah, Georgia	544	494	397	785	743	598	1490
Scranton, Pennsylvania	1196	1172	1085	2375	2465	2274	6129
Seattle, Washington	684	714	719	1727	1553	1869	4934**
Sheridan, Wyoming	1255	1279	1320	2957	2763	3198	8008
Shreveport, Louisiana	638	630	499	950	950	769	1938
Sioux City, Iowa	1518	1342	1265	2999	2644	2583	6898
Spokane, Washington	1092	1132	1057	2647	2461	2583	6355
Springfield, Illinois	1234	1225	1039	2250	2502	2002	5373
Springfield, Missouri	1109	1088	893	1977	1868	1674	4428
Syracuse, New York	1313	1279	1172	2647	2632	2491	6893
Tacoma, Washington	737	790	756	1941	1771	1951	5181**
Terre Haute, Indiana	1179	1185	992	2168	2087	1840	4872
Toledo, Ohio	1306	1315	1079	2558	2557	2189	6077
Topeka, Kansas	1224	1118	1008	2111	1860	1883	4969
Trenton, New Jersey	1079	1028	930	1969	1997	1760	4933
Utica, New York	1398	1358	1144	2855	2886	2537	6796
Valentine, Nebraska	1387	1304	1245	2892	2813	2725	7039
Walla Walla, Washington	933	981	896	1964	1960	1909	4808
Washington, D. C.	989	947	896	1730	1777	1741	4626
Wichita, Kansas	1137	1037	955	1947	1735	1783	4673
Williston, North Dakota	1733	1475	1591	4031	3338	3658	9323
Winnemucca, Nevada	1051	1087	1080	2475	2519	2589	6427**
Yakima, Washington	1014	1090	1091	2274	2162	2428	5599

†Nome data are for November.

*Includes August.
**Includes July and August.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Copper is Adaptable



WHEN you put your professional experience and skill just as earnestly into a small project as into a large one, you are following the highest standards of good business. And when you specify or install Revere Copper Water Tube for heating and water lines in any building, large or small, you are applying a similar principle. For you know that this fine tube will do justice to the rest of your work, will fully uphold your reputation.

Revere Copper Water Tube (99.9% pure copper) is seamless and is cold drawn with a gun-barrel finish inside. It is deoxidized and is free from flaws and blemishes. Joints are made with either soldered or compression fittings.

Designed for water supply, heating, air conditioning and similar services in all types of buildings, this tube is stamped with the Revere name and the type at regular intervals. Look for these identification marks—they insure full wall thickness and the close gauge tolerances so essential for tight sweated joints.

In making your plans you can specify such long-lived Revere materials as Copper Water Tube and Pipe; Red-Brass Pipe; Sheet Copper for tanks, ducts, pans and trays; Sheet Herculoy for tanks; Dryseal Copper Refrigeration Tube (dehydrated and sealed); Copper oil burner, heat control and capillary tubes.

Revere materials are handled by Revere Distributors in all parts of the country. The Revere Technical Advisory Service, Architectural, is always ready to serve you. Call your Revere Distributor.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in principal cities, distributors everywhere

• • •

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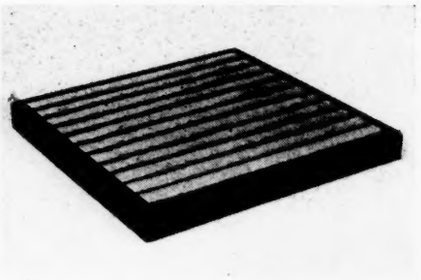
NEWS OF EQUIPMENT AND MATERIALS

Air Filter

NAME—Badger replaceable air filter.
PURPOSE—General filter use.
FEATURES—Made of glass fibre, filter provides greater filtering surface be-



cause of its rib design. Special flange construction makes a good air seal in the frame. Although lighter in weight than other replaceable filters, great rigidity and sturdiness are assured by strong cardboard frame cemented to rib structure.
MADE BY—*Badger Corp., 341 E. Brown St., Milwaukee, Wis.*

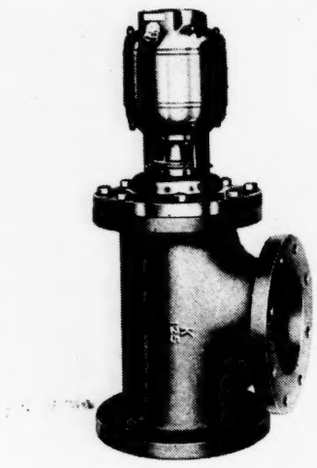
Air Dryer

NAME—Gasflux 636 series dryer.
PURPOSE—To remove moisture from air and gas lines.
FEATURES—Dryer consists of an outer shell of 6 in. O.D. seamless steel tubing and a removable inner shell or cartridge of rolled sheet metal with a perforated metal bottom. A cast bronze head with inlet and outlet openings is bolted to a flange welded to the outer shell. Depending upon drying conditions, there is a choice of three drying media for the cartridge — Fiberglas, calcium chloride, and activated alumina. After being used to capacity, the cartridge can be reactivated by heating. It is also possible to use two dryers in series, charged with different media to increase drying efficiency. Incoming air must first pass downward between the inner and outer shells and then passes out through the drying medium the full length of the cartridge before reaching the outlet valve. Brackets are provided for mounting dryer on a wall, or unit may be suspended by pipe straps.

MADE BY—*The Gasflux Co., 198 Wayne St., Mansfield, Ohio.*

Circulator

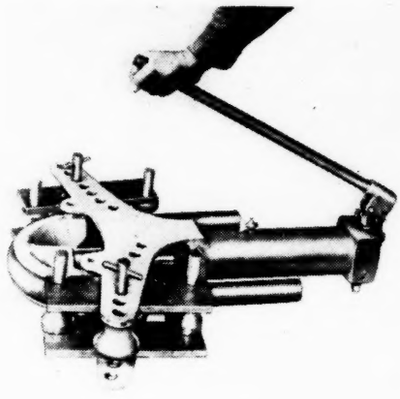
NAME—Axiaflo circulator.
PURPOSE—For handling large volumes of liquids at low heads.
FEATURES—Units have full ball bearing, totally enclosed dynamically balanced motors. The 4 in. size is pro-



vided with a ¼ hp motor and the 6 in. a ½ hp motor.
SIZES AND CAPACITIES — Discharge capacities of sizes now available are 280, 700, 950 and 1,200 gpm. Line to be expanded to 12 in. size with capacity of 2,500 gpm.
MADE BY—*Ruthman Machinery Co., 1810 Reading Rd., Cincinnati 2, Ohio.*

Pipe Bender

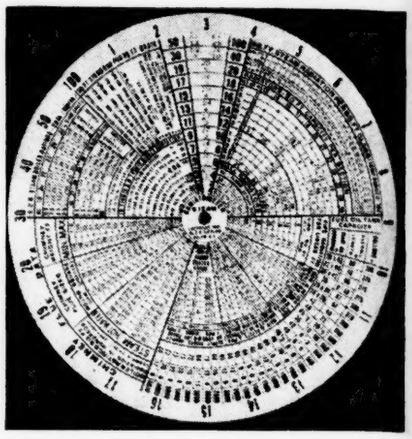
NAME—Attachment for portable Prestal Bender.
PURPOSE—To make cold 180° bends



of wrought iron and steel pipe.
FEATURES—Attachment makes possible the production of 180° bends in one single operation. Designed chiefly for bending pipe for radiant heating piping systems. Machine can bend ⅜ to 2 in. dia pipe.
MADE BY—*Tal's Prestal Bender, Inc., Milwaukee 2, Wis.*

Radiation Calculator

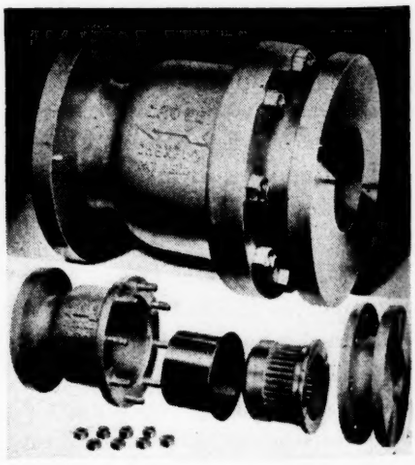
NAME—Heat-O-Meter.
PURPOSE — Calculating device for measuring radiation for steam and hot water systems.



FEATURES—Round dial has three concentric celluloid printed discs. Dial contains sizes of mains, returns, risers, radiator sizes and capacities, round and sectional boiler net ratings, chimney flue sizes, hot water tank sizes and capacities, fuel oil tank sizes and capacities, hot water generator capacities and other data.
MADE BY—*Heat-O-Meter, 424 W. 42nd St., New York 18, N. Y.*

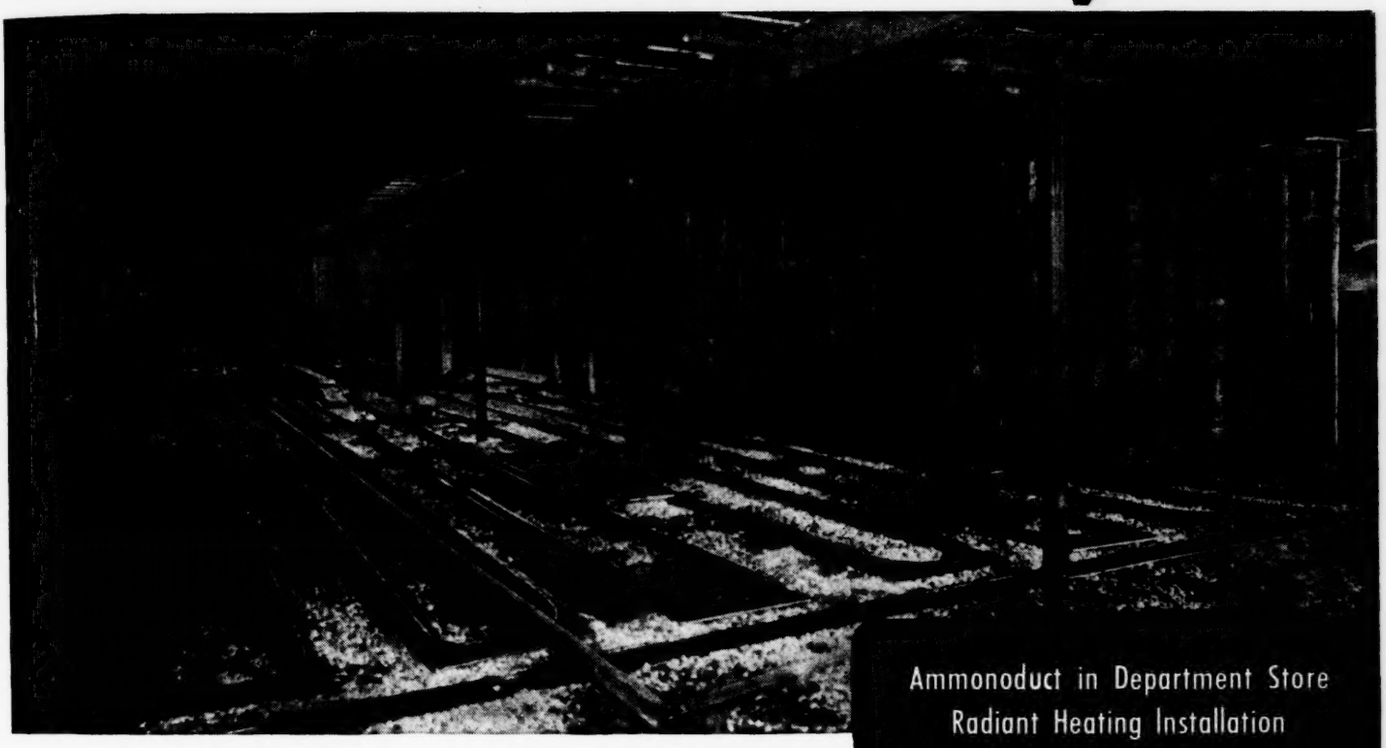
Check Valve

NAME—Grove Chexflo valve.
PURPOSE—General check valve use.
FEATURES—A synthetic rubber tube, stretched over a slotted, cup-shaped metal core, expands to open, and contracts to close. Makers claim that



because the tube closes prior to the commencement of back flow, there is no tendency to start pressure impulses or water hammer through the flow line. Unit said to be suited for handling corrosive and erosive gas.
MADE BY—*Grove Regulator Co., 6536 Green St., Oakland 8, Calif.*

USE THIS DUCTILE PIPE FOR *Radiant Heating*



Ammonoduct in Department Store Radiant Heating Installation

The big advantages of Ammonoduct pipe for radiant heating are its strength and ductility. Ammonoduct is so ductile that it can be bent cold—quickly, safely, inexpensively . . . even to close centers—without danger of fracturing the metal wall or collapsing the bend. There's no need for pipe filler. And because annealing is likewise unnecessary, it's a simple matter to make cold bends right at the job.

You'll like the easy way Ammonoduct welds, too. No special welding technique is required. Even welders with but slight experience have little difficulty in making tight, sound welds.

Corrosion-resistance? Even though corrosion is of minor importance in a properly designed radiant heating installation, it is good to know that Ammonoduct has stood the test of time in effectively resisting corrosion in applications far more severe than that encountered in this type of heating. This, together with the fact that Ammonoduct's coefficient of expansion is practically identical with that of the plaster or concrete used in ceilings, walls and floors, assures the user of year-after-year economy and dependability.

Made by the continuous-weld process from a special low-carbon open-hearth steel, Ammonoduct is furnished in sizes from ½ in. to 3 in., standard weight and extra-strong—and in uniform 21 ft. lengths, plus or minus 1 in.

Even with all its advantages, Ammonoduct sells for exactly the same price as regular steel pipe. So whenever radiant heating is specified, plan to use Ammonoduct. Full information is available from your Bethlehem distributor.

Radiant heating system in a 34' x 130' addition to the Saratoga Springs, N. Y., unit of M. N. Landau Stores, Inc., Chain (Junior Department Stores). The job called for a total of 2400 ft. of 1" and 1¼" Ammonoduct pipe to carry hot water under thermostatic control. After being placed on insulating strips (½" thick) over a 4" stone fill, the Ammonoduct pipe coils were covered with 4" of stone concrete finished off with 1½" of terrazzo. Pipes were spaced 24" apart. All the bends were made cold.

Heating Contractor, Charles O'Connor, Saratoga Springs, N. Y. *Architect,* Morris L. Tepman, Jersey City, N. J.

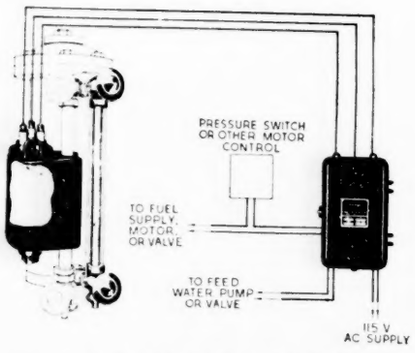
AMMONODUCT

EASY WORKING . . . BENDS COLD

★ BETHLEHEM STEEL ★

Feedwater Control

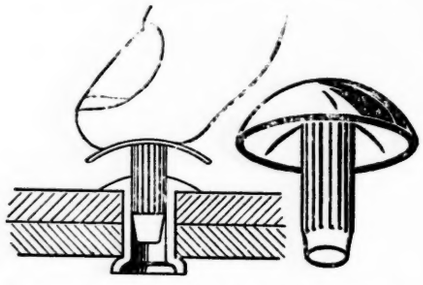
NAME—Fireye boiler feedwater control type B177N.
PURPOSE—Fully automatic control for



commercial and industrial boilers.
FEATURES—Water level is maintained automatically without float or pressure switches. The control is through electronic means.
OPERATION—Probe fitting is mounted parallel to the water column and wired to the Fireye control. Probes within the probe fitting mark boiler feedwater pump on-and-off levels and a low water danger point. When water falls below the middle probe, the device closes the circuit controlling the pump and water feeds into the boiler until the top probe is reached. When the lowest probe is reached, the fuel supply is shut off and an alarm is sounded.
MADE BY—*Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.*

Ornamental Plug

NAME—Umbrella plug.
PURPOSE—To have rivet head match surface color or texture of material being fastened.
FEATURES—Plug fits into the center of the hollow type Cherry rivet and provides a smooth plug completely covering the head of the rivet. Plugs are available in aluminum, copper or plastic and can be colored to match or harmonize with the surrounding surface. Shank of plug is knurled and tapered and is pushed in by hand.
SIZES AND CAPACITIES—For use with



Cherry rivets of 1/8, 5/32, 3/16, and 1/4 in. diameters.
MADE BY—*Cherry Rivet Co., 231 Winston St., Los Angeles 13, Calif.*

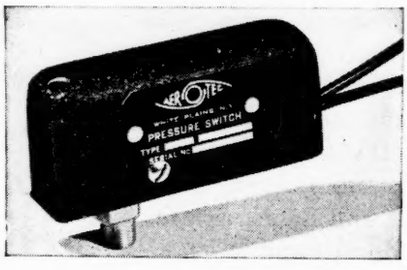
Pressure Switch

NAME—Pressure-Clix.
PURPOSE—Snap action switch.
FEATURES—Pressure adjustment can be securely locked and sealed against tampering. Wire connections are

made through the grommeted opening in the steel cover to the insulated terminals thereby eliminating spliced wires. Diaphragm is of Fairprene backed by a mushroom shaped plate of restricted travel to prevent undue stresses. Snap action switch can be changed to normally-off or normally-on by moving one wire. All parts are rustproof. Switch is designed for electrical loads up to 10 amp.
MADE BY—*The Nason Co., 7663 Epworth Blvd., Detroit 4, Mich.*

Control Switch

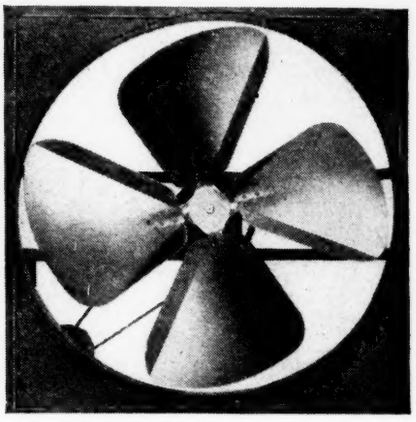
NAME—Aerotec pressure switch.
PURPOSE—Control of liquids or gases that will not corrode brass.
FEATURES—Switch is available in three designs, all rated at 10 amp, 110 v a-c. Type M-500 has an externally adjustable range with a



fixed differential. Type M-600 can be reset manually from the outside. M-700 has an adjustable differential and is available with normally open contacts. Other models can be specified as normally-closed, normally-open, or double throw. Pressure connection is by means of a ⅛ in. nipple.
MADE BY—*Aerotec Co., White Plains, N. Y.*

Air Mover

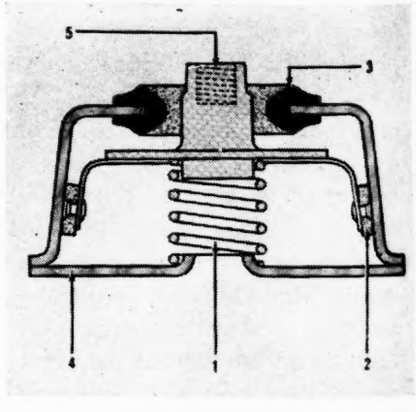
NAME—Silent Breeze.
PURPOSE—Fan for air movement.
FEATURES—Fan has a long balanced axle shaft designed for noiseless operation. Four-blade fan is die cut and die formed to insure accuracy and balance. An all welded, angle frame construction is used. A silent V-belt drive is adjustable by sliding motor on base.
SIZES AND CAPACITIES—Comes in eight sizes from 7,000 cfm and ¼ hp to 21,000 cfm and ¾ hp.



MADE BY—*Holcomb & Hoke Mfg. Co., Indianapolis 7, Ind.*

Anti-vibration Mount

NAME—Robinson Vibrashock unit.
PURPOSE—Anti-vibration mounts for the air conditioning industry.
FEATURES—Makers claim that unit averages 90% absorption of vertical and lateral vibrations over a wide range of frequencies. Principal load is carried by a stainless steel spring with three-way freedom of movement and built-in three-way limiting snub-



bers. Details of design are shown in cut-away view — 1. Principal load-bearing spring. 2. Damping mechanism to kill low frequency oscillation. 3. Three-way limiting snubbers. 4. Metal housing with standard attachment holes in base. 5. Load-carrying central stud with standard thread.
MADE BY—*Robinson Aviation, Inc., Teterboro, N. J.*

Why DUNHAM HEATING

Means "Better Heating"

To the experienced architect or consulting engineer the history of a product reveals the soundness of its manufacture and the endurance of its performance. The history of Dunham — more than four decades of leadership in the science of heating — tells a story of extensive research, development, and specialized engineering. Upon this solid foundation your specification of Dunham rests securely.

Highlights of Dunham History

1900—First Dunham Thermostatic Radiator Trap assembled and tried out.

1903—C. A. Dunham Company incorporated in Iowa and manufacturing started at Marshalltown plant.

1909—C. A. Dunham Company, Ltd., organized in Canada. Work started on new plant in Marshalltown, Iowa.

1911—National Vacuum Heating Company absorbed by C. A. Dunham Company.

1912—New office building and factory built at Toronto, Canada.

1917—Dunham Packless Radiator Valve placed on the market.

1919—Sales offices established in London and Paris.

1921—General offices of company moved to Chicago.

1922—Line of Dunham Return Traps put on market.

1924—Young Pump Company, Michigan City, Ind., acquired by C. A. Dunham Company.

1925—Walter H. Prier Company foundry at Marshalltown, Iowa, acquired by C. A. Dunham Company.

1926—Dunham Building, Chicago, completed.

1927—The Dunham Differential Vacuum Heating System announced in national engineering and architectural magazines.

1928—C. A. Dunham Company, Ltd., of the United Kingdom organized in London, England.

1930—Dwyer Equipment Company, Chicago, acquired by C. A. Dunham Company.

1930—Plant built at Michigan City, Ind., to manufacture pumps, unit heaters and convectors.

1935—Plant built at London, England.

NOTE: Since 1927, thousands of outstanding Dunham Differential installations have been made from coast to coast in the United States and Canada, also in Great Britain, Europe and Asia. General MacArthur's headquarters in Tokyo, for example, is heated by the Dunham Differential system.

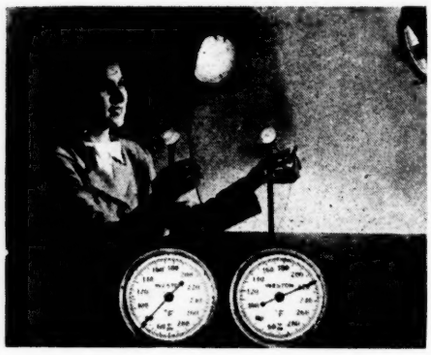
C. A. DUNHAM COMPANY

450 East Ohio Street, Chicago 11, Illinois

FACTORIES: Marshalltown, Iowa • Michigan City, Ind. • Toronto, Canada • London, England

Heat-Absorbing Glass

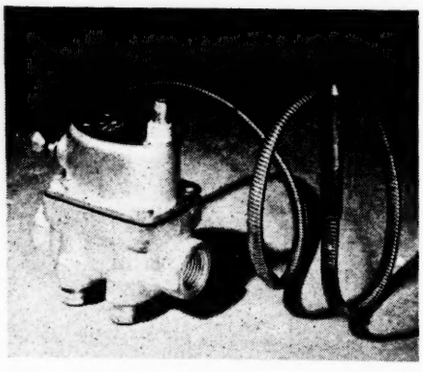
NAME—Heat-absorbing glass.
PURPOSE—Glass capable of absorbing heat radiations.
FEATURES—Glass absorbs approximately 90% of infrared heat radia-



tions and transmits 85% of light out of a possible 92%, for 8% is always lost by reflections. It transmits colors accurately, is chemically stable, resists weathering without requiring a surface treatment, and can be molded, ground, polished and fabricated like ordinary glass. It can be used as a heat screen to protect movie and television actors against scorching heat generated by powerful lights and can reduce the air conditioning load required for studios.
MADE BY—*American Optical Co., Southbridge, Mass.*

Thermovalve

NAME—MR-2 Safety Thermovalve.
PURPOSE—Safety device for gas control applications.
FEATURES — Unit handles manufactured, natural or LP gases and is designed for such service as space and unit heaters, central and floor furnaces, water and range heaters, and steam boilers. Device has a sealed electro magnetic assembly, heavy duty 5/16 in. round thermo-

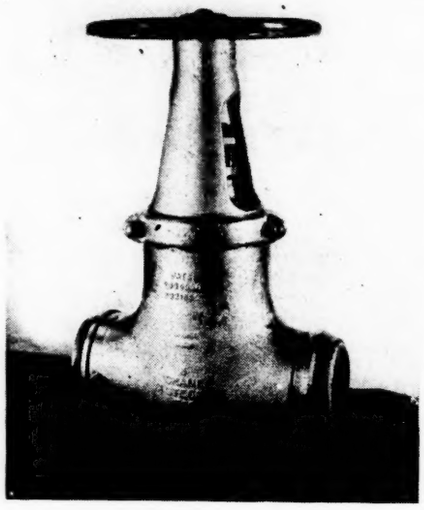


couple, flexible armored cable leads, and a visual valve position indicator.

Necessary valve operating current is supplied by the heat of pilot flame applied to the thermocouple element. Failure of flame automatically closes the valve. Push button reopens valve.
MADE BY—*General Controls, 801 Allen Ave., Glendale 1, Calif.*

High Pressure Valves

NAME—Pressure-Seal valves.
PURPOSE—For general high pressure, high temperature steam service, primarily in the 1500 lb and 900 lb pressure classes.
FEATURES—Valve design utilizes the pressure in the valve to seal the bonnet joint. Unit has shorter end to end dimensions and occupies less space. The makers claim that for the 1500 lb class valve, there is a reduction of 40 to 60% in weight when compared with the conventional bolted bonnet valves, and that no strength has been sacrificed. The disc for gate valves has built-in flexibility which eliminates sticking of the disc. The design is to insure proper guidance of the disc for its full travel. Body rings are of new design and permit straight line flow with minimum friction. Line in-



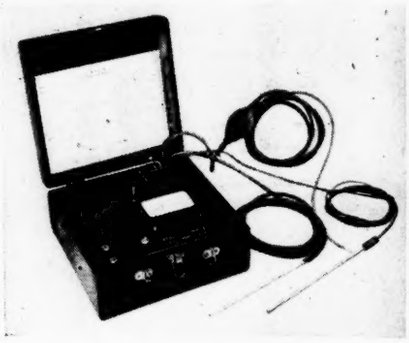
cludes gate, glove, angle and automatic stop check valves.
MADE BY—*Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.*

Humidity Indicator

NAME—Hygrolabels.
PURPOSE—An indicator of severe humidity conditions.
FEATURES—Small, sensitized labels smaller than a postage stamp, indicate by change of color when humidity approaches the point where mold, mildew, or rust may take place. Label is a brilliant blue-green when dry and a pink when humidity conditions are severe. When dry conditions again prevail, color reverts to blue-green. Labels may be placed in powdered or granulated material without contaminating the product. Labels come in roll and strip form with a self-adhering back and a protective backing. Each label may be used over and over again.
MADE BY—*Eljay Enterprises, P.O. Box 891, Newark 1, N. J.*

Stack Gas Analysis

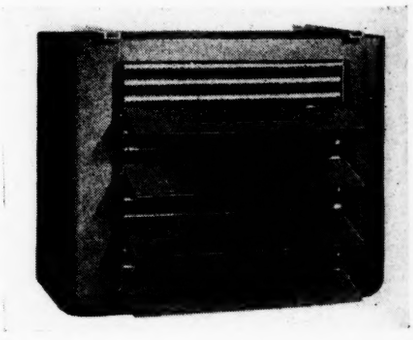
NAME—Stack-O-Meter.
PURPOSE—An electrical instrument for stack gas analysis.
FEATURES—Portable instrument of 11 lb weight indicates CO_2 percentage,



stack temperature and draft readings. Carbon dioxide readings are obtained from gas samples collected through a hand aspirator bulb. Stack temperatures are read on the same dial and are obtained from a thermocouple mounted in the gas sampling tube. Draft measurement is through a separate tube but read on the same meter. Electric current is obtained from standard flashlight batteries. Safety switch shuts off battery current on closing the cover of the instrument box.
MADE BY—*The Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.*

Overhead Blowers

NAME—Rempe overhead blowers.
PURPOSE—Low temperature cooling.
FEATURES—Unit is built for use with all types of refrigerant including brine and prestone. There is provision for different air velocities to



furnish the right air volume for specific cooling jobs. The coils are designed so that the outlet velocities of the refrigerants are well within safe limits. All tubes and bends are of full area with no obstructions. Louvers are individually adjustable to permit controlled and uniform air flow.
MADE BY—*The Rempe Co., 340 N. Sacramento Blvd., Chicago 12, Ill.*

Who's to Blame—

if Air-Filter Maintenance Costs get "OUT OF LINE?"

When the cost of getting clean air gets "out of line"—somebody has slipped. Perhaps it was due to the original specification, perhaps the maintenance man's budget couldn't stand the load or perhaps the front office overlooked the balance between original cost and upkeep which can be maintained when the right equipment and Dust-Stop* Air Filters are used.

The man who installs the equipment?

The Heating and Ventilating Engineer won't be on the spot if he has specified adequate equipment and recommended Dust-Stops. Many engineers prefer Dust-Stops and the complete, ready-to-assemble steel cell frames, because of their ready adaptability to virtually any system, regardless of the C.F.M. requirements.

The proved efficiency of the Dust-Stop, flexibility of installation, easy access to filters, and the low cost of this part of the system are but a few of the other reasons for the widespread preference for these efficient replacement-type air filters.

The man who maintains it?

The maintenance man will be in the clear if Dust-Stops are in the system. Dust-Stops can be obtained quickly from local suppliers and replacement of Dust-Stops in the frame cells is accomplished with a minimum of man power and time.

***OR* the management men who bought the equipment?**

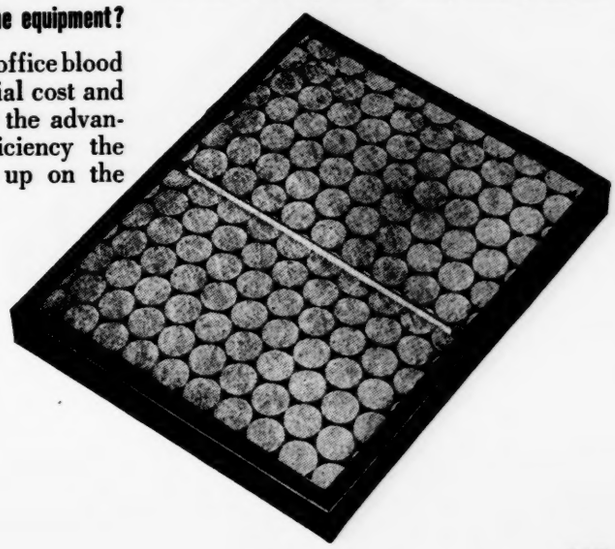
Dust-Stops help keep front-office blood pressure down. Where initial cost and upkeep are balanced with the advantages of air filtering efficiency the use of Dust-Stops shows up on the profit side of the ledger.

The Dust-Stop Air Filter is constructed of packs of glass fibers (Fiberglas*) coated with an adhesive, faced with metal grilles and bound on the edges with a fiberboard frame.

The Fiberglas fibers, packed to proper density, form an exceptionally effective medium for air filtration. Being glass, they are inorganic, chemically stable, resistant to heat, corrosive vapors and most acids. And, being glass, they do not absorb the nonodorous, nonevaporating adhesive with which they are coated. Each impinged particle of dust is quickly soaked, acting as a wick to carry adhesive to other particles. Thus, the adhesive remains effective until the filter is so heavily loaded with dust that resistance to air flow calls for replacement.

For complete information and typical Dust-Stop installation details, see Sweet's Files or write: *Owens-Corning Fiberglas Corporation, 1912 Nicholas Building, Toledo 1, Ohio.*

In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.



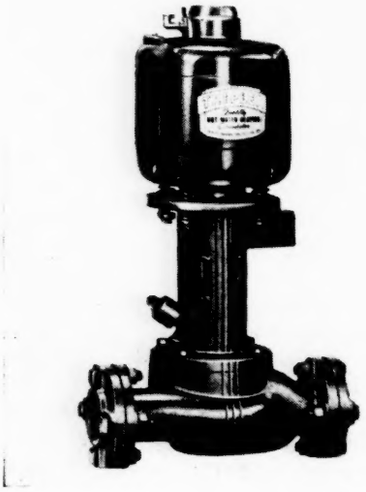
DUSTOP AIR FILTERS

REG. U.S. PAT. OFF.

—a FIBERGLAS product

Hot Water Circulator

NAME—Triplex vertical circulator.
PURPOSE—Flow control of hot water heating.
FEATURES—Balanced inlet impeller of circulator is made up of die cast bronze hub with side flanged cover plates. Precision gauge manufacture assures a close fit between the outer diameter of the impeller and bored diameter of the body. Combination seal ring and metallic packing are said to be effective for water exclusion and grease-retaining bearing system. Unit has a conventional flanged body for easy attachment to the heating system. Manufacturing



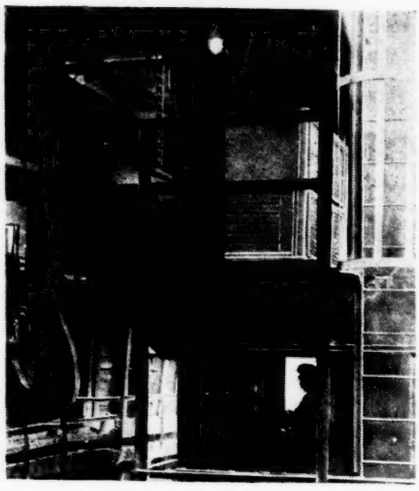
methods make possible complete interchangeability of parts with those of similar model and number. Standard models are furnished with spring-mounted, vertical sleeve bearing, 110-volt, 60-cycle, single phase, fractional hp motors—with automatic reset overload relays. Electrical knock-out boxes prevent transmission of noises between motors and heating systems.
SIZES AND CAPACITIES—Vertical models made in 1-, 1¼-, 1½- and 2-in. pipe sizes. Horizontal models are available for 2½- and 3-in. sizes.
MADE BY—*Triplex Heating Specialty Co., Peru, Ind.*

Protective Coatings

NAME—Amercoat.
PURPOSE—Surface treatment for protective coatings on metal.
FEATURES—Amercoat No. 59, a surface preparation for zinc is a treatment for galvanized metal surfaces prior to application of a protective coating. No. 60 is a similar treatment for copper and brass. These treatments are for use where shot or sandblasting is impractical.
MADE BY—*Amercoat Division of the American Pipe and Construction Co., P.O. Box 3428, Terminal Annex, Los Angeles 54, Calif.*

Crane Cab Cooler

NAME—Dravo air conditioning unit for crane cab.
PURPOSE—For cooling crane cabs working over ingot molds or soaking pits.
FEATURES—Unit is fitted to the top



of the cab and is self-contained. Only an electric power connection is required. Equipment is enclosed in a steel frame and housing. Air supplied to the cab is cooled, cleaned and constantly circulated. Acid fumes are eliminated by a special fume absorber. Maintenance consists of changing throw-away type filters.
LITERATURE AVAILABLE—Bulletin 515.
MADE BY—*Dravo Corp., 300 Penn Ave., Pittsburgh 22, Pa.*

Special Electrode

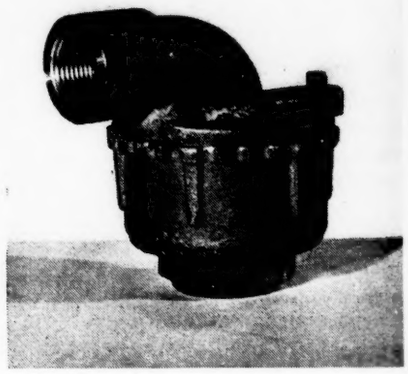
NAME—Type W-56 arc-welding electrode.
PURPOSE—For welding of carbon-molybdenum steels.
FEATURES—Operates satisfactorily on either a-c or d-c current. It can be used in the flat, vertical and overhead positions and it produces a relatively flat deposit, particularly in the vertical position. Makers claim that it has excellent creep-resisting qualities. Electrode produces a stable spray-type arc and deep penetration.
MADE BY—*General Electric Co., Schenectady, N. Y.*

Gauges

NAME—Streamlined U. S. gauges.
PURPOSE—General use.
FEATURES—With its new group of streamlined gauges, the makers claim higher quality, longer life, plus increased sales appeal. Streamlines of the neutral gray case are heightened by a striking ivory-toned dial with contrasting red and black graduations.
MADE BY—*United States Gauge Division, American Machine and Metals, Inc., Sellersville, Pa.*

Flexible Joint

NAME—Flexo joint.
PURPOSE—Flexible pipe connections to moving machinery for carrying steam, air or fluids.
FEATURES—Design permits joints to swivel through 360 degrees. Standard joint is made of bronze and is designed for working pressures up to 250 lb and temperatures not exceeding 500F. For pressures up to 1350 lb and temperatures above 500F, joints are made of cast steel. By varying the composition of the inner seal, joints may be used for wide variety of service. Design permits full pipe area in all positions. Joints

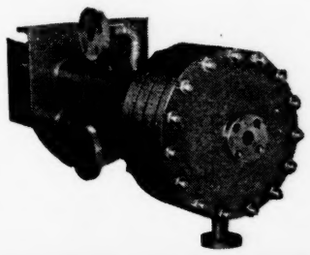


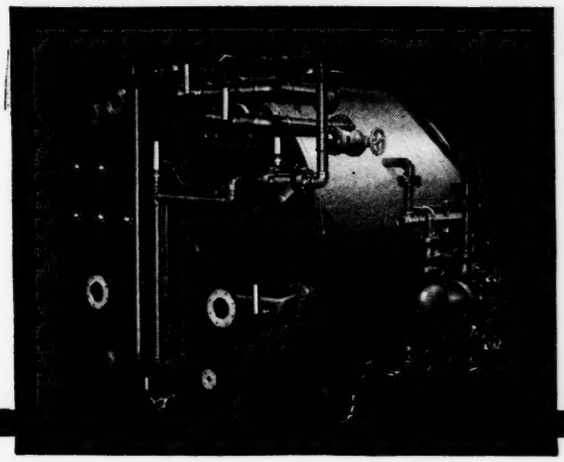
consist of four parts, each one interchangeable.
SIZES AND CAPACITIES—Made in all standard pipe sizes from ¼ to and including 3 in. Four styles are available.
MADE BY—*Flexo Supply Company, Inc., 4221 Olive St., St. Louis 8, Mo.*

Flexible Tubing

NAME—Spiratube.
PURPOSE—For portable or semi-permanent ventilation installations.
FEATURES—A spring steel helix core causes it to spring out to its fully extended length. Inside surface of tube is free of wire ridges. Sharp bends may be made without the use of elbows or special fittings. Tube, it is claimed, is non-collapsible under plus or minus pressures and is retractable to about one-eighth of its extended length. Tube is made of long fibre duck having a bursting strength of 170 psi. Fabric is covered with a thermoplastic and is fire-resistant. Built-in couplings permit quick joining or disconnecting.
SIZES AND CAPACITIES—Comes in standard diameters from 3 in. to 16 in. and in lengths of 10, 15 and 25 ft.
LITERATURE AVAILABLE—Bulletin.
MADE BY—*The Warner Brothers Co., Spiratube Division, Bridgeport, Conn.*

Left to right, a Fuel Oil Heater, Evaporator Distiller and Feed Water Heater manufactured by B & G for the U. S. Coast Guard.





THE "KNOW-HOW" THAT WON THIS NAVY AWARD

IS BACK AT ITS OLD JOB OF BUILDING EQUIPMENT FOR LOW-COST WATER HEATING

You can sum up the reasons for the popularity of B & G Water Heaters in a single, significant statement —"sound engineering, backed up by excellent materials and modern manufacturing methods capable of translating good design into fine product."

Years of experience in building water heaters has resulted in units featured by the most efficient heat transfer designs and constructions . . . hence B & G Water Heaters operate with greatest economy. To specify " B & G" is definite assurance that full value will be delivered, both in long service life and low cost operation.

"WU" Instantaneous Water Heater

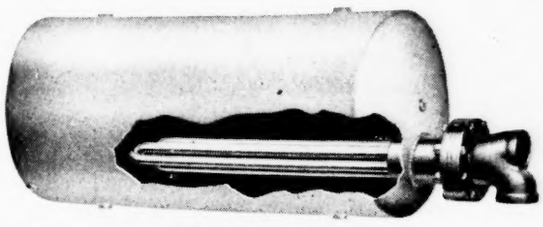
HEATERS FOR HOME AND INDUSTRIAL USE

B & G Water Heaters cover the entire utility range, including tank and tankless models for either water-to-water or steam-to-water heat transfer. Whether you need a heater for a cottage or a swimming pool, you'll find the proper type and capacity in the B & G line.

Today's water heater market, both for replacement and new installations, offers a tremendous profit opportunity. Prepare yourself to cash in on it by writing today for B & G catalogs.

For cash savings plus positive temperature control

The "WU" Instantaneous Water Heater is equipped with a B & G Booster, which pumps boiler water through the shell, thereby greatly increasing heater capacity. Whenever service water temperature drops below the desired degree, the Booster automatically pumps boiler water through the shell until service water is again at the correct temperature. Pumped circulation permits smaller pipes and fittings—hence material cost is cut to the bone and cutting and threading can be done on the job.



B & G Tank and Heater

This model both heats and stores the water in the same unit. It can be operated by passing either steam or hot water through the coil and is an excellent heater for hard water territories.

BELL & GOSSETT COMPANY
Dept. K-4 MORTON GROVE, ILLINOIS

Canadian Licensee:
S. A. Armstrong Ltd., 115 Dupont St., Toronto

WATER HEATERS

Getting Personal

Bruce A. Jacobi *(Air Conditioning Women's Apparel Stores*, page 65) was born in New York City. He attended the College of William and Mary, Williamsburg, Va., where he obtained his B.S. in 1933. Four years later he received the degree of Mechanical Engineer from the Carnegie Institute of Technology, Pittsburgh, Pa.

From 1937-38 he was designing control equipment for Freiz & Co., Baltimore, and for the next two years, Mr. Jacobi was with Johnson and Morris, heating contrac-

Bruce A. Jacobi

tors. During this period he worked on the air conditioning systems for the Netherlands, Italian, Turkish and Polish pavilions at the World's Fair, New York City.

Since 1939, with the exception of a period of naval service, he has been chief engineer for Lerner Stores Corp. From 1942-45 he took orders from Uncle Sam and served as Lieutenant, U. S. Navy.

Mr. Jacobi has the interesting work of designing the air conditioning and heating systems for stores of the Lerner chain.

. . . Since the Last Issue

Ten district managers have been named to head the sales organizations of the **General Electric Co.'s** Air Conditioning Department throughout the country, the new appointments marking the inception of a revised organization of the department's field staff, according to an announcement by J. P. McIlhenny, manager of sales. The new appointments became effective January 2.

R. S. Thurston with headquarters in Boston; **L. T. Brockbank** with headquarters in New York; **C. S. Morash** with headquarters in Philadelphia; **G. B. Hightower** with headquarters in Atlanta; **J. F. Murphy** with headquarters in Cleveland; **J. F. Carland** with headquarters in Chicago; **J. P. Turner** with headquarters in Kansas City; **V. L. Strange** with headquarters in Dallas; **E. H. Howes** with headquarters in San Francisco; **W. H. Stover** with headquarters in Portland, Ore.

At the annual meeting of the **Midwest Stoker Association**, Chicago organization of prominent wholesalers and distributors of mechanical coal stokers, **Joseph G. Beard** was elected president for the ensuing year succeeding John J. Hayes, who held this office since August, 1944. Mr. Beard is assistant manager, stoker division, Illinois Iron & Bolt Company, and Mr. Hayes is manager of the Auburn Stoker Company.

W. B. Connor Engineering Corp. announce the return from the services of **Lt. J. E. Orr** who has returned to his position of advertising manager after an absence of five years.

Major Parker Devlin has returned from over three years of overseas duty and has again taken over command for **McDonnell & Miller, Inc.**, in the New England States. In his 44 months in service, Major Devlin saw action in the Caribbean Defense area, where he did service with AAA defense setting up gun positions in the jungles of Panama to protect the locks. Then, following an interlude of intensive study which ended in the Army Air Forces School of Applied Tactics, the Major headed for the Pacific in December 1943. The first stop was Hawaii; then the Marshall Islands; then to Ulithi; finally to Guam where he was assigned a dual mission of AAA defense of the air fields and a secondary mission of mopping up the Japs from where the 77th Division and Marines had left off. At Guam his unit received a Presidential citation for efficiency of mopping up operations and patrol skill. Major Devlin is taking over the duties that have been handled in his absence by Howard Peary of the McDonnell & Miller Metropolitan New York staff.

Major P. Devlin

Surface Combustion Corp., Toledo, Ohio, has appointed **O. R. Lutz** as a service engineer on Janitrol gas-fired heating equipment made at the company's Columbus, Ohio plant.

Carrier Corp., manufacturer of air conditioning and refrigeration equipment, today announced the appointment of five new distributors, as follows: **General Utilities Distributors**, Chicago; **Appliance Distributors, Inc.**, Indianapolis; **Thiele-Winslow Company**, San Antonio; **Allied Distributing Corp.**, Norfolk, and **Bickford Brothers Co.**, Rochester and Buffalo. This brings to thirty-two the number of distributors who now are franchised to handle one or more lines of Carrier products. These distributors have under them approximately 3,600 dealers. In addition, Carrier has granted franchises directly to some 190 dealers.

In a series of branch organization changes, **Minneapolis-Honeywell Regulator Co.** has annnounced the opening of new offices in Denver and Salt Lake City and expansion of existing offices in Washington, D. C., Los Angeles and Spokane.

The Korfund Co., Inc., Long Island City, manufacturers of vibration control units of cork, rubber, and steel construction have been appointed sole distributor of Armstrong Standard Density Vibracork. Vibracork, to be furnished by Korfund in two to four inch thicknesses, is a product of Armstrong Cork Co., for vibration isolation. Heavy Density Vibracork can be furnished on special order.

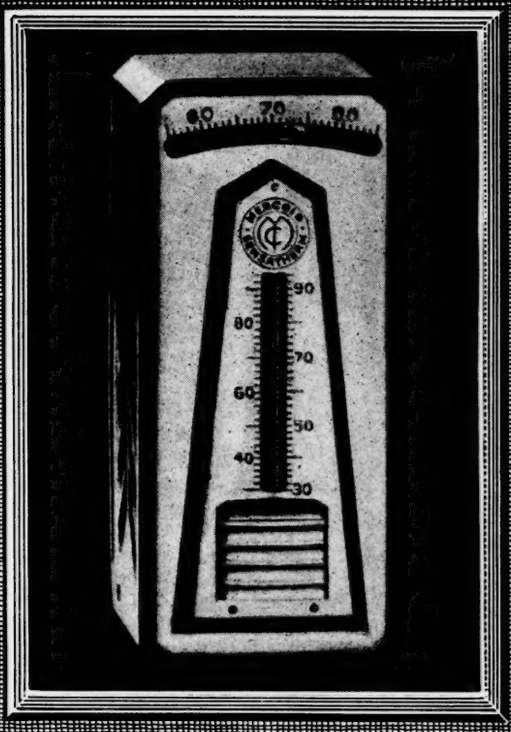
After four and a half years in the U. S. Navy, where he rose to the rank of Lieutenant-Commander, **George J. Boepple** has returned to the field engineering force of the **Alco Valve Co.**, St. Louis manufacturers of automatic refrigerant controls, to take over the Philadelphia office. Mr. Boepple received a degree in engineering chemistry at Washington University, and joined the Alco engineering staff in 1936 after working for two years as an apprentice brewmaster at the Anheuser-Busch Brewing Co. He later became manager of the Alco service department and was transferred in 1938 to the New York office as a field engineer.

G. J. Boepple

FOR HOME

FOR INDUSTRY

MERCOID SENSATHERM—THE THERMOSTAT OF BEAUTY, MECHANICAL PERFECTION AND IDEAL ROOM COMFORT.



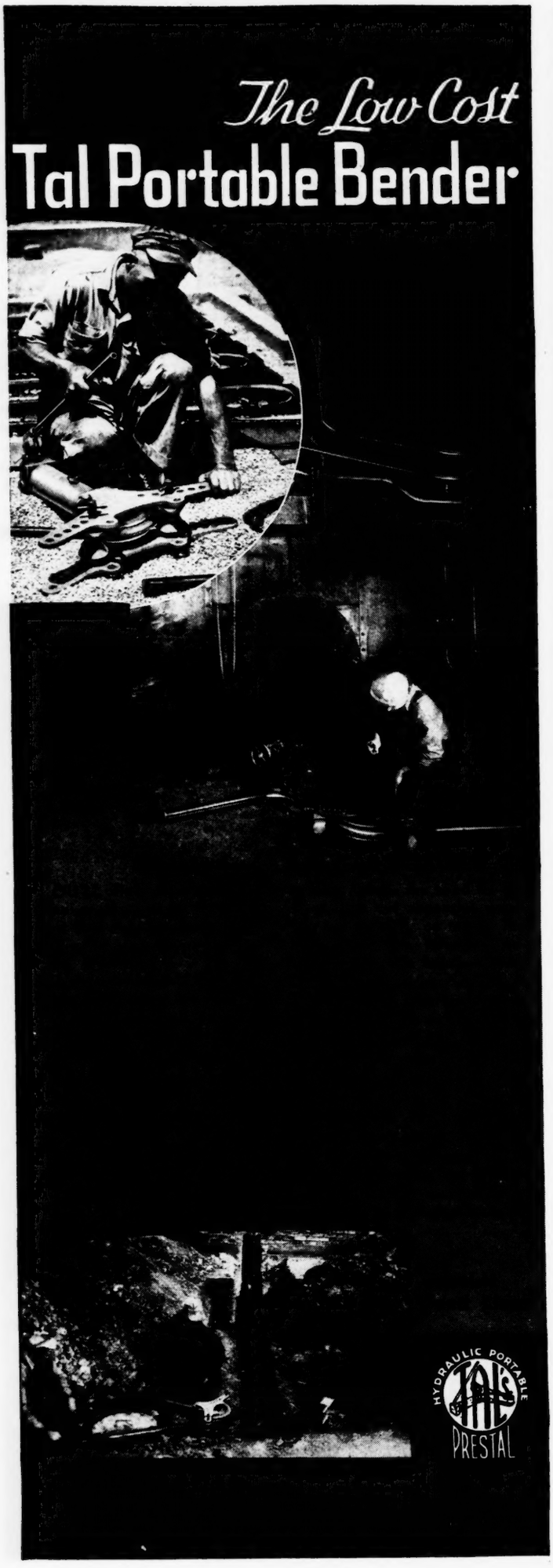
MERCOID

THE MARK OF CRAFTSMANSHIP IN FINE AUTOMATIC CONTROLS, FOR NEARLY A QUARTER OF A CENTURY

HERMETICALLY SEALED MERCURY SWITCHES USED EXCLUSIVELY
CATALOG SENT UPON REQUEST.

THE MERCOID CORPORATION · 4203 BELMONT AVENUE · CHICAGO 41 · ILL.

MERCOID PRESSURE AND TEMPERATURE CONTROLS HAVE A WIDE RANGE OF INDUSTRIAL APPLICATIONS



H. A. Thrush Co. announces the return of **Richard Eisbrenner** to its field organization. Mr. Eisbrenner spent considerable time in the engineering department and in the company's Philadelphia organization before the war. He has received his honorable discharge from the United States Army after almost 5 years of service in India, Persia and at various points throughout the United States. He is locating in Cleveland, Ohio, and his territory will include most of northeastern Ohio and part of Pennsylvania.

Following five years of military service, including more than two years overseas duty with an anti-aircraft battalion in the European Theatre, **Lewis L. Dollinger, Jr.** has received his discharge and is again associated with the **Dollinger Corp.** In addition to duties connected with his recent election as vice-president of the company, Mr. Dollinger will act in a sales engineering capacity. He is a mechanical engineer, Cornell University class of 1938, and spent 2½ years in the engineering and sales department of Dollinger Corp. before entering military service.

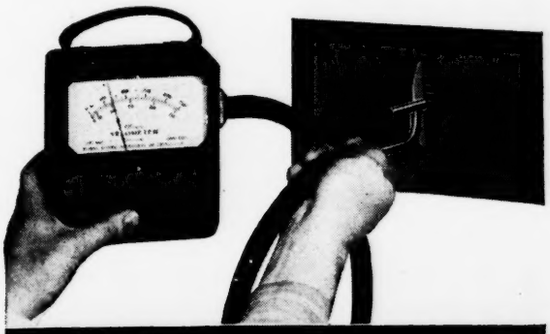
L. L. Dollinger

Owens-Corning Fiberglas Corp. has been notified that the Reconstruction Finance Corporation has accepted its $650,000 bid for the purchase of a 35-acre industrial property in Kansas City, Kansas. The purchase was described at the firm's general offices as a major step in the Fiberglas expansion program. Harold Boeschenstein, president of the corporation, said that facilities will be installed to manufacture Fiberglas building insulation and roofing materials, pipe wrap used for protection against underground corrosion, industrial insulation and equipment insulation. Part of the facilities planned for the Kansas plant will be used to manufacture fine glass fibers of a type newly developed for a wide variety of purposes.

Announcement has been made by W. F. Lisman, President of **Leland Electric Co.**, Dayton, of the appointment of **J. J. Daggon** to the post of vice-president in charge of sales. Mr. Daggon has been associated with the company since 1930, and for the past three years was assistant to the vice-president in charge of engineering. Prior to that he was eastern district sales manager with offices in New York City. He is a graduate of Ohio State University with degrees in mechanical and electrical engineering.

Harrison J. Hedrick, who served for 2 years as a commodity specialist with the Commercial Refrigeration and Air Conditioning Section of the Office of Price Administration, Washington, D. C., and formerly assistant sales manager of the Refrigeration Division of **Mills Industries, Inc.,** Chicago, has been appointed manager of the division by Gordon B. Mills, Vice-President in Charge of Sales. Prior to his association with Mills, Mr. Hedrick was for ten years president and general manager of Jewett Refrigerator Co., Buffalo, N. Y. In 1931 he joined the commercial refrigeration division of R. Cooper, Jr., and it is this position he left to join Mills Industries in 1941. He assumed his position with the Office of Price Administration in 1942 and returned to Mills in 1943. His position at Mills Industries, Incorporated, places him in complete supervision of design, production and sales of condensing units and allied equipment.

H. J. Hedrick



Alnor VELOMETER

the direct reading air velocity meter

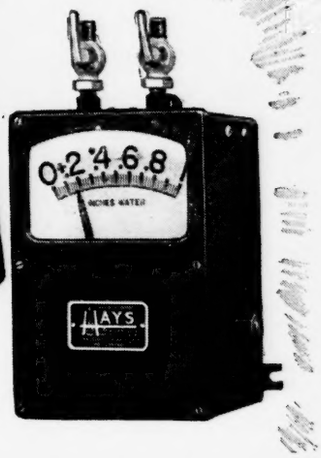
Air speed in feet per minute is read directly and instantly on the scale of the Alnor Velometer. Anyone can use this simple instrument—there are no calculations, no leveling, no timing, and no conversion tables. This convenient instrument allows quick checking of draft, leaks, velocities at air conditioning outlets, and any other air movement. Quick, accurate air velocity measurements give a valuable check on efficiency of equipment.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm, and up to 3 inches total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for bulletin with complete data.

ILLINOIS TESTING LABORATORIES, INC.
420 NORTH LA SALLE STREET
CHICAGO 10. ILLINOIS

Warns you when AIR-RESISTANCE IS EXCESSIVE-

HAYS AIR-FILTER GAGE



Air filters clog with dirt—can't be avoided. Result—air circulating efficiency goes steadily down, and power costs just as steadily go up.

Know the condition of your air filters—by means of the Hays Air-Filter Gage: simple, fool-proof, easy to install—tells you when it's time to clean or change filters—sounds an alarm or flashes a light if desired.

Write for Publication 46-751 and prices, to 965 Eighth Avenue, Michigan City, Indiana.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

You Get Everything You Want in a Stoker Line When You Sell...

FREEMAN STOKERS

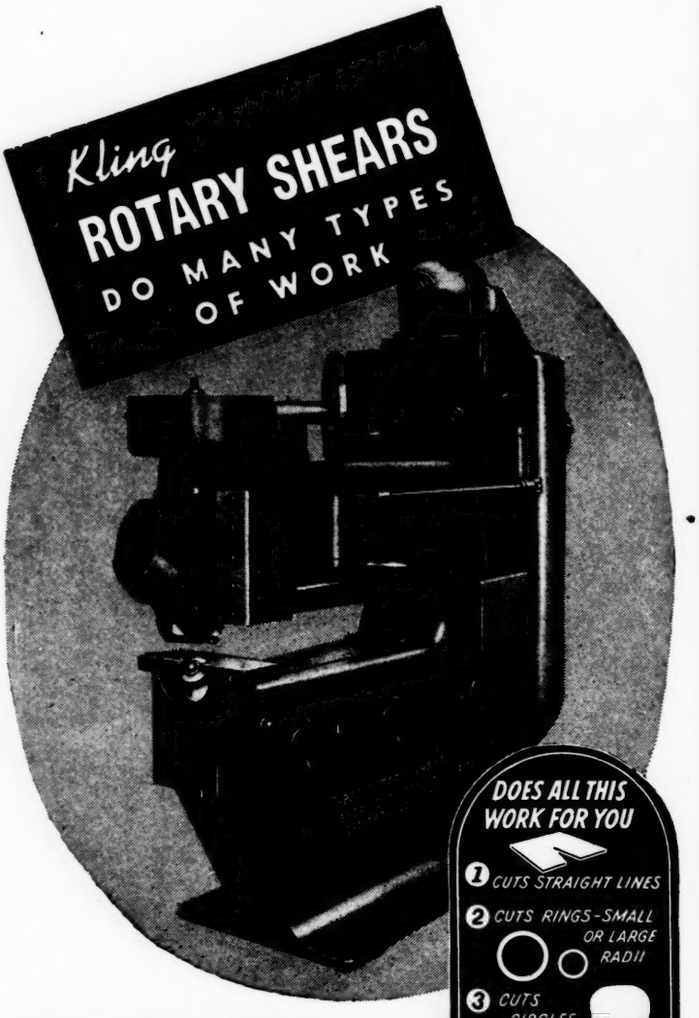
FIRST CHOICE OF AMERICA'S FOREMOST HEATING ENGINEERS

PIONEER OF THE STOKER INDUSTRY . . . ONE OF THE LEADERS IN NATIONAL SALES VOLUME!

ALL SIZES NOW AVAILABLE

A COMPLETE LINE
★
YEARS OF EXPERIENCE
★
PERSONAL COOPERATION
★
ENGINEERING LEADERSHIP
★
FINANCIAL STRENGTH
★
AGGRESSIVE PROMOTION

FREEMAN STOKER DIVISION
ILLINOIS IRON & BOLT CO.
918 S. MICHIGAN AVE., CHICAGO 5, ILLINOIS



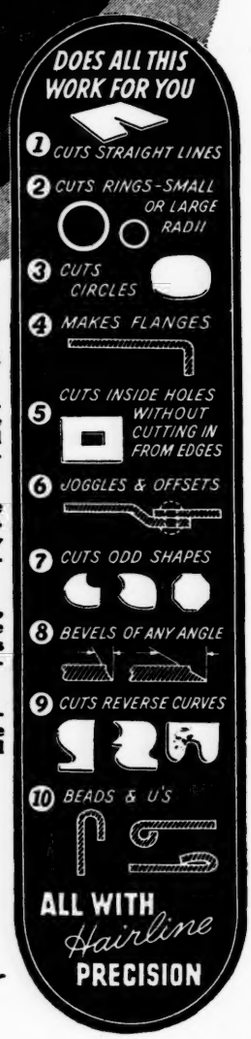
Yes, and With Hairline Precision

Rapid operation . . . Hairline Accuracy . . . the use of Kling Rotary Shears marks the latest development in cutting mild steel, and sheet metal, up to 1-inch with amazing savings in time, labor, and production costs.

For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.

In metal working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done, — this machine is held in high regard for its versatility and economy of operation.

This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.


DOES ALL THIS WORK FOR YOU
1 CUTS STRAIGHT LINES
2 CUTS RINGS - SMALL OR LARGE RADII
3 CUTS CIRCLES
4 MAKES FLANGES
5 CUTS INSIDE HOLES WITHOUT CUTTING IN FROM EDGES
6 JOGGLES & OFFSETS
7 CUTS ODD SHAPES
8 BEVELS OF ANY ANGLE
9 CUTS REVERSE CURVES
10 BEADS & U'S
ALL WITH Hairline PRECISION

Send Today for Bulletin No. 245

which will give you specific facts, and specifications. No obligation involved. Users of heavy equipment of Kling Rotary Shears' class will receive a copy of this Bulletin promptly, on request.

KLING BROS. *Engineering Works*

1304-HV No. Kostner Ave., Chicago 51, Illinois

EXPORT DEPT. 1111 South Ferry Building, New York 4, N. Y.

Frank E. Nutt has been named assistant sales manager of the **Crocker-Wheeler Electric Mfg. Co.**, division of **Joshua Hendy Iron Works** at Ampere, New Jersey. He was replaced at his former post as manager of the company's Washington, D. C. office by **Mr. A. M. R. Lawrence, Chevy Chase,** Maryland resident. Mr. Nutt is a native of Colorado, graduate of the University of Denver, and has held positions in the General Electric Company at Schenectady, New York, and at their high-

F. E. Nutt

A. M. R. Lawrence

voltage laboratory in Pittsfield, Mass., where he was a design engineer in the transformer division. Since 1942, he has been associated with Crocker-Wheeler sales: first, as sales engineer in its New York office and then as manager of its Washington, D. C. office just prior to his recent appointment. Mr. Lawrence has spent many years working with government agencies in Washington as a marine sales engineer on both mechanical and electrical equipment. Mr. Lawrence was originally with the Westinghouse Machine Co. and spent twenty-two years with Westinghouse in Pittsburgh and Washington, resigning as marine sales manager in 1937. He maintained his own engineering office in Washington until joining the Maritime Commission in the Fall of 1942 for the duration of the War.

Two promotions in **The National Radiator Co.'s** sales organization have been announced by Paul B. Holmes, manager of sales, Heating Division. **John C. Barnes,** former manager of the company's Washington branch, has assumed his new duties as branch manager for Philadelphia. **Huber F. Seltzer,** veteran of thirty-four years in the sales department, replaces Mr. Barnes as manager of the Washington, D. C., branch.

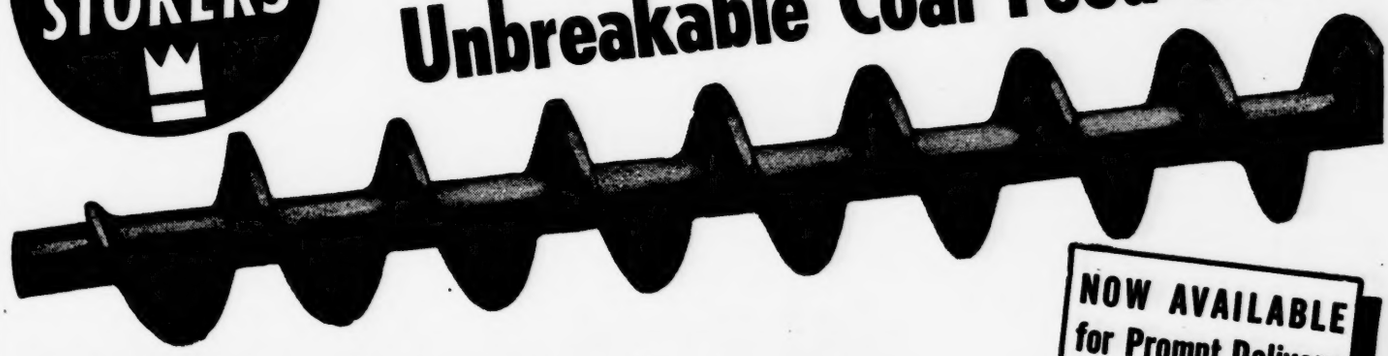
Advancement of **J. J. Donovan,** eastern divisional manager, to the post of assistant general sales manager of **Airtemp Division, Chrysler Corp.,** was announced here today by H. A. Malcom, general sales manager. Mr. Donovan's transfer to Dayton strengthens the home office staff with additional broad experience in the direction of sales and distribution activities. His original assignment with Airtemp was as regional manager in New York, before he became eastern manager.

J. J. Donovan

The **Pennsylvania Ultraviolet Co.,** with headquarters at 717 Highland Building, Pittsburgh, Pa., has been appointed Sterilamp distributor in the tri-state area of Western Pennsylvania, Eastern Ohio and Northern West Virginia, according to Charles W. Flood, Jr., manager of the **Westinghouse Sterilamp** department, Bloomfield, N. J. The new company, operated in partnership by brothers, **Cooke Bausman, Jr.,** and **Sanford Bausman,** will serve as a sales and engineering firm, planning and specifying bactericidal ultraviolet equipment for product and personal protection in offices,

For STOKERS

The CROWN Unbreakable Coal Feed Screw



NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★Crown's complete line of all-steel Coal Feed Screws meets every replacement and production requirement. Produced for both domestic and industrial stokers. Crown Screws are available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. Uniformly smooth surfaces insure that coal will flow freely and easily through the flights. Because it is all-steel with continuous weld, the Crown Coal Feed Screw guarantees long, continuous operation with full customer satisfaction. Crown is in a position to make prompt delivery on all sizes.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY
1207 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

POWERS TEMPERATURE and HUMIDITY CONTROL

When you want accurate and dependable automatic temperature or humidity control for Heating, Ventilating and Air Conditioning Systems or Industrial Processes call in a Powers engineer. With a very complete line of self-operating and compressed air operated controls we are well equipped to fill your requirements.

THE POWERS REGULATOR CO.
2718 Greenview Avenue CHICAGO

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★ Over 50 Years ★
of Temperature and Humidity Control

DE-STA-CO Blower Wheel Housings

of Standard Dimensions

Made in sizes to fit 4½, 5, 6, 7½ and 9 inch wheels and in widths to suit single or double inlet wheels . . . also individual parts for your own assembly.

De-Sta-Co housings are engineered for maximum efficiency and quietness in operation . . . neatly finished. Send for "De-Sta-Co Blower Housings" bulletin; gives complete information, including essential dimensions.

DETROIT STAMPING CO.
Established Over 30 Years
375 Midland Ave • Detroit 3, Mich.

Most anybody looks on a cut-rate diamond deal with suspicion. The bargain usually fails to materialize.

Carry that suspicion into the field of plumbing supplies the next time you are offered merchandise at big discounts. You may be buying a load of trouble.

In fact, the only safe course is to patronize the reputable jobber in your vicinity who makes a specialty of carrying trustworthy merchandise.

KUHNS BROTHERS CO.
DAYTON 1, OHIO

K
CAST FITTINGS

"K" fittings are carried in stock at Malleable Iron Fittings Co., Branford, Conn.; M. I. F. stocks at Kuhns Bros. Co., Dayton, Ohio.

stores, restaurants, theaters. manufacturing establishments, farms and homes. The firm's territory is bounded by Erie, Pa.; Youngstown, Ohio; Wheeling, W. Va., and Altoona, Pa.

The following organization of **General Electric's Industrial Heating Division** has been announced by **C. L. Ipsen,** manager of the division. **R. D. Ketner** is now manager of sales of the industrial heaters and devices section; **O. S. Haskell** is manager of sales of the electric furnace and oven section, and **K. E. Kjolseth** is manager of sales of the induction and dielectric heating section. **R. M. Cherry** is assistant manager of the division.

The eastern district of the **Johnson Service Co.** announces the appointment of **Lt. Col. John H. Colby** as manager of the company's Boston office, 20 Winchester St., Boston, Mass. Lt. Col. Colby, formerly employed as a salesman in the Boston office, will direct the sales engineering and service for the Johnson system of Automatic temperature and humidity control as marketed for the New England States.

Appointment of **Dr. Waldo H. Kliever** to the newly created post of director of research has been announced by the **Minneapolis-Honeywell Regulator Co.** The new director will coordinate research activities in all Honeywell divisions in Minneapolis, and in addition will instigate new research projects in the field of automatic control devices ranging from aircraft and railroads to heating and air-conditioning. A graduate of Bethel College in Newton, Kansas, where he received his A.B. degree, Dr. Kliever received his doctor's degree in physics from the University of Chicago in 1939. Joining Minneapolis-Honeywell in June, 1940, Dr. Kliever was assigned to the engineering department and a year later was made chief physicist for the newly formed Aeronautical division. During the war Dr. Kliever devoted his full time to the development of a number of aeronautical control devices, many of which were of a highly secret nature. Under his direction an electronic fuel measuring system was developed which reduced reading error to two per cent compared with a 15 per cent error in all previous means of fuel measurement. He also did much experimental work in connection with various types of navigational and bombing computors for through-the-clouds, radar bombing, and for the recently revealed Castor project wherein bombers loaded with explosives were remotely flown into enemy installations. Other devices on which he has worked include blind landing controls, a new electronic compass for aircraft and the design and balancing of gyroscopes.

Dr. W. H. Kliever

Davis Engineering Corp., Elizabeth, New Jersey, manufacturers of "Paracoil" feed water heaters and heat exchangers — announce the appointment of **C. Edward Bernard** as manager of agency sales.

C. L. Bensen has been appointed manager of the refrigeration division of **McQuay, Inc.,** Mr. R. C. Colman, vice-president and general sales manager has announced. For the past three years Mr. Bensen has been in charge of the aircraft division of McQuay, Inc., and prior to that was chief engineer for ten years. He has been with the McQuay organization since 1928 and is thoroughly familiar with its products and potentialities. Mr. Benson's new duties will be directed towards the establishment of the new jobber policy on refrigeration products. Mr. Bensen is a member of the ASHVE and ASRE and has been quite active in both organizations.

C. L. Bensen

fedders

FOR installations 15 to 45 ft. above working zone. Circular & square types. Copper tubes and copper fins. . . .

•

Write for Catalog 12C-1

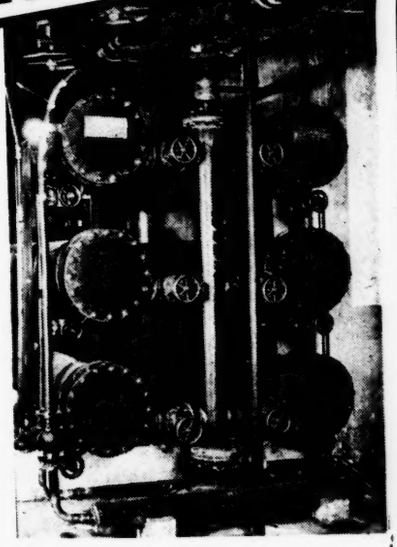
NEW *Series 12*

Downblow UNIT HEATERS

FEDDERS-QUIGAN CORPORATION, BUFFALO

CONSECO

Air Conditioning HEAT EXCHANGERS



Twenty years' specialized experience designing, fabricating and servicing heat exchangers assure sound design, quality construction and economical operation with any type refrigerant. Engineering assistance gladly furnished. Write.

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Conseco CO_2 heat exchangers operating at 1200 psi in various Sanger chain theatres.

SERVICE

CONDENSER SERVICE & ENGINEERING CO., INC.

63 RIVER STREET, HOBOKEN, N. J. • *Phone Any Time*

CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
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OPENS UP A BIG

NEW MARKET

BECAUSE IT IS SOLD AT A PRICE MORE PEOPLE CAN AFFORD

$7.50

LIST F.O.B. CHICAGO
115 V., 60 CYCLE

Features

Switch Rating: 35 amperes at 115 volts. Single pole only.

Timing Motor: Synchronous. Self-starting. Fully enclosed. Permanently lubricated.

Manual Control: The switch may be turned "on" or "off" manually whenever desired irrespective of the time settings.

Automatic Reset: Regardless of whether the switch has been turned "on" or "off" manually, the time cycle is always resumed automatically.

Accessibility: Entire mechanism may be removed by loosening one screw. Motor, switch, terminal block, etc., easily replaced.

Safety: Listed by Underwriters' Laboratory Re-examination Service.

Guarantee: One year guarantee against defects in workmanship and material.

Manufacturer: Established 1891. Manufacturers of the Cutawl, fare registers, coin meters, range timers, etc.

USES

Signs • Store Window Lighting • Night Lights • Flood Lights • Apartment Hall, Lobby, Stairway and Yard Lights • Room Coolers • Attic Fans • Stokers • Oil Burners • Gas Burners • Pumps • Poultry House Lights.

WRITE FOR CATALOGUE AND NAME OF NEAREST DISTRIBUTOR

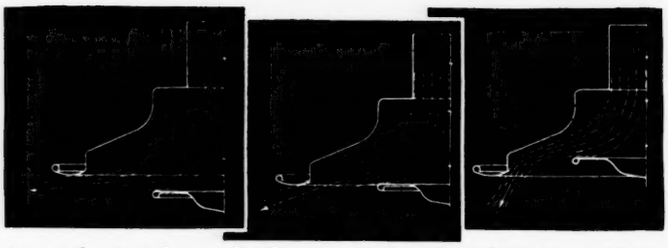
INTERNATIONAL REGISTER CO.

Dept. 26D 2624 W. Washington Blvd. Chicago 12, Ill.

How *adjustable* air diffusers increase the efficiency of supply air diffusion.

Better mixing of room and supply air, more uniform temperatures throughout the occupied zone and noiseless, draftless air diffusion are accomplished with

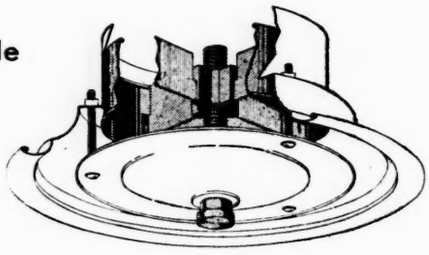
KNO-DRAFT *adjustable* Diffusers



Any desired angle from vertical to horizontal at your fingertip.

By simply turning the air adjustment screws (easily accessible from under the unit) the inner cone of any KNO-DRAFT Diffuser may be raised or lowered to secure any angle of air direction required by ceiling heights, system balancing, and individual or seasonal requirements. Thus the diffuser becomes more effective whether it is used in cooling, heating, ventilating, or combined systems, because it can expel chilled air parallel to the ceiling or eject heated air downward to prevent stratification.

Type K Adjustable Diffuser with Type D Volume Damper.



Pa. and pat. pending

Any desired volume at your fingertip

Every KNO-DRAFT Diffuser can be equipped with a built-in volume damper (easily adjusted by hand-turning knob under diffuser) which varies the outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

Thus KNO-DRAFT Diffusers can be adjusted quickly and accurately to the angle and volume needed to meet a wide variety of conditions, and as a result, the factors of temperature variation, temperature fluctuation, drafts and noise can be minimized considerably.

The W. B. Connor Engineering Corp. maintains a staff of specialists and district representatives in leading cities to assist you with any air distribution problem.

FREE HANDBOOK

Contains clear sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers.

For your copy write Dept. E-12.

W. B. CONNOR ENGINEERING CORP.

Air Diffusion *Air Purification* *Air Recovery*

114 E. 32nd Street — New York 16, N. Y.

The Hays Corp., Michigan City, Ind., manufacturers of boiler room and industrial instruments and controllers, announces that, effective January 1, Cochrane Flow Meters, formerly manufactured by The Cochrane Corp., Philadelphia, became a part of the Hays line of products and will be sold by Hays representatives as Hays-Cochrane instruments for flow, liquid level, pressure and temperature measurement. The flow meters will continue to be manufactured in Philadelphia by **The Penn Industrial Instrument Corp.**—an organization comprised of the same men who have been responsible for the production of these meters for many years. The corporation is headed by **William C. Bennett,** president and general manager with **William Melas** as vice-president and chief engineer and **Kenneth C. Markley** as vice-president and works manager.

Penn will manufacture the present line of Cochrane Flow Meters exclusively for The Hays Corp. Penn expects to make early announcement of a line of air-operated controllers for temperature, pressure, flow and level to be marketed directly by Penn through the present Cochrane flow meter representatives with offices in 42 cities in U. S. and Canada.

The addition of flow meters to the Hays line will round out their line of draft gages, combustion meters, flue gas analyzers and automatic combustion controllers, giving the user the advantage of obtaining all of these boiler room and industrial process instruments and controllers from a single source.

Daniel Meyer and **Fred Skirving,** who have been associated with the instrument division of Cochrane Corporation for a number of years, have joined the Hays engineering staff at Michigan City and will specialize on flow meters and flow measuring problems.

David H. Butler, a native of Elgin, Ill., and formerly a WPB administrator in Washington, has been appointed sales manager of the Toronto factory branch of the **Iron Fireman Manufacturing Co.** of Canada, Ltd. A veteran of 20 years with the Iron Fireman organization in Chicago, he was granted a leave of absence to go to Washington, D. C., in August, 1941, to set up a plumbing and heating division of the Office of Emergency Management. He served as chief of the heating branch, which later became the plumbing and heating division of the WPB. In March, 1943, Mr. Butler left the WPB to become a Washington representative for a group of Oregon manufacturers.

D. H. Butler

In line with a policy recently approved and adopted by the board of directors of the **Stoker Manufacturers' Association,** is the announcement by Marc G. Bluth, executive secretary, that a newly created post of technical director of the association has been filled by **Lloyd L. Connell,** of Richmond, Indiana, who until a few months ago was a Lieutenant-Colonel in the United States Army Air Forces. In this new position, Mr. Connell will work under the direction of the association's engineering and research committee headed by **A. O. Dady** of Bradley, Illinois. Among his many duties will be co-ordination of engineering activities involving cooperation with anthracite and bituminous coal research organizations, technical societies, smoke abatement organizations and other groups allied with or interested in the automatic coal burner industry.

With plans for reorganizing and expanding their Chicago organization, **Mehring and Hanson Co.** announce that **H. C. Wyatt,** vice-president, is now in charge of the Chicago office and of mid-western activities.

President John W. Laverack of **The Dampney Company of America,** Hyde Park, Boston 36, announces the appointment of **Lachlan W. MacLean** as Boston sales office manager. With 10 years experience with the Dampney Company, most recently as New York Manager, Mr. MacLean takes over to serve New England users of Apexior and Thur-Ma-Lox protective coatings. Mr. MacLean, first associated with The Dampney Company in 1936 in the Philadelphia sales office, was manager of the New York sales office from 1937 until his appointment to Boston. Born in Richmond, Va., he was educated at Richmond Academy, received his B.S. degree from Washington and Lee University in 1921 and his M.S. degree from M. I. T. in 1924.

L. W. MacLean

Sarco Co., Inc., 475 Fifth Ave., New York City, has opened an office at 1129 Vermont Ave., N. W., Washington 5, D. C., in charge of **H. F. Collins.** For a number of years Mr. Collins represented the company in eastern Pennsylvania.

The Edward Valve & Mfg. Co., Inc., East Chicago, Indiana, has been renamed **Edward Valves, Inc.** The company, which manufactures cast and forged steel valves, is a subsidiary of the Rockwell Mfg. Co. In announcing the change, Col. Willard F. Rockwell, chairman and president of the Rockwell Mfg. Co., emphasized that the change in name was a matter of simplification for marketing purposes and that no change in personnel or sales policies was planned. W. F. Crawford continues as president of Edward Valves, Inc. An expansion of manufacturing facilities is planned at the Edward plant. The first of the new buildings is under construction.

In line with recent expansion plans Mr. A. H. Armerding, president of the **New Jersey Stoker Corp.,** announced the appointment of **William J. Brennan** of 215 Johnson Avenue, Teaneck, N. J. as public relations director of the corporation and its affiliate the Insulight Company. Recently discharged from the Army Air Forces where he held the rank of captain, Mr. Brennan served 14 months overseas with the Flying Tigers. Prior to entering the service the former captain was employed by the Liberty Mutual Insurance Company in New York. He is a graduate of Syracuse University where he majored in journalism and advertising. Upon completion of his studies Mr. Brennan joined the Audit Bureau of Circulations in New York and was later employed by J. M. Mathes, Inc., in the same city. In addition to public relations he will have charge of the corporation's advertising and sales promotion program. He is married and has one son, William Frederick, who was born Dec. 30 of last year.

W. J. Brennan

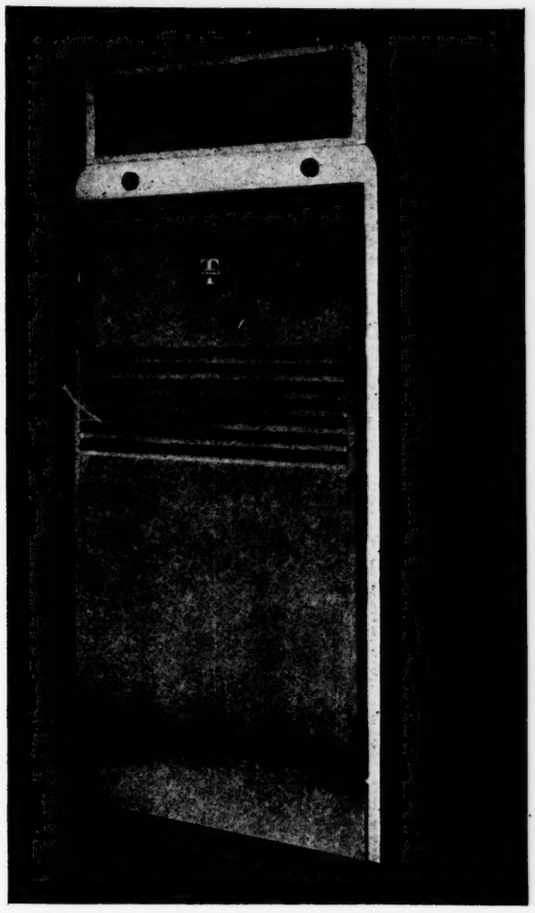
E. A. Taylor joins the **Allied Control Co., Inc.** as general sales manager. Mr. Taylor comes to Allied from the General Electric Company. **J. S. Speer** has been appointed eastern sales manager. **Hugh M. Noble** will be western sales manager with headquarters at Chicago.

John P. Birmingham, president of the White Fuel Company of Boston, has been elected president of the **Independent Oil Dealers' Association of New England.** John W. Scott retires after serving five years as president, besides giving much time to government committees on fuel oil. **H. E. Davenport** was elected vice-president and **Clyde G. Morrill,** treasurer.

TYPHOON

PROP-R-TEMP UNITS

PROP-R-TEMP self-contained air conditioning units are a natural for an eager market. Attractive, compact, easy to install, inexpensive to operate, built with the moving parts completely accessible, PROP-R-TEMP represents an achievement in air conditioning engineering. Available in 3 and 5 ton units.



Tested Typhoon equipment for smooth performance in all types of conditioning systems is now available for prompt delivery.

TYPHOON PRODUCTS

- **PROP-R-TEMP Self-Contained Air Conditioning Units, 3 and 5 Tons.**
- **TYPHOON Evaporative Condensers.**
- **TYPHOON Spray Coolers (Air Washers).**
- **PROP-R-TEMP Air Conditioning Units.**
- **MONSOON Heating Coils (2-Header and Non-Freeze Types).**
- **MONSOON Direct Expansion Coils.**
- **MONSOON Water Coils (Continuous Tube and Free Drain Types).**

Several dealer territories open. Inquiries and orders receive prompt attention.

ICE-AIR CONDITIONING CO., INC.

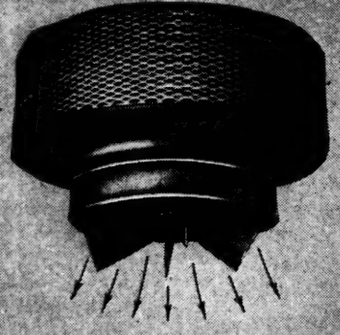
794-6 Union Street **Brooklyn 15, N. Y.**

McCORD
HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

A. H. Armerding, president of the **New Jersey Stoker Corp.**, announced recently the purchase of new manufacturing and warehousing facilities at 206-210 Johnson Ave. in Newark. New Jersey Stoker has been the district distributor for **Iron Fireman** products since 1927. Although much of the heavy equipment will be moved to the new address, the sales and administrative offices of the corporation will continue to be operated from 1153 Broad St. Mr. Armerding also announced that the Johnson Avenue building will be the manufacturing headquarters for the Insulight Co., an affiliate of the corporation which makes and sells all-weather combination windows. Previous manufacturing operations of this company were carried on at 537 Central Ave. in East Orange, N. J.

Ed. Ostermeier, former director of engineering for Apex All-Weather Products Co., of Chicago, is now operating his own company, **Apex Engineering Co.**, Chicago 6, Ill. The new organization will handle specialized maintenance problems as applied to steam and hot water distribution systems, cleaning internally all types of equipment such as steam turbines and other prime movers, as well as lines, radiators, and traps and other cleaning services working toward restoration of original resistance balance.

Bruce A. Irwin has been appointed sales manager of the **Hammel-Dahl Co.** of Providence, R. I., manufacturer of automatic control equipment. Mr. Irwin will assume complete responsibility for sales as well as advertising. Mr. Irwin during the war years of 1942 through 1944 was Secretary of the Petroleum Administration for War's Materials Coordinating Committee, which allocated all material used by the petroleum industry. While in Washington, D. C., Mr. Irwin was at the same time Chief of PAW's Materials Requirements Section and Petroleum Projects Section. He also sat on WPB's Industrial Engine Committee, which allocated all industrial engines for both military and civilian use. Mr. Irwin, in association with Mr. E. T. Dahl, is the originator of the "Free Flow" angle control valve which is used in control of refinery cracking plant units. Both Mr. Irwin and Mr. Dahl also initiated the continuously connected type of hand wheel for control valves, which materially helped relieve the critical valve shortage in the construction of many aviation gasoline and synthetic rubber plants.

B. A. Irwin

Dampney Co. of America, Hyde Park, Boston 36, Massachusetts, through John W. Laverack, president, announces its acquisition of **Thurmalox Co.** of Doylestown, Pa., manufacturers of Thur-Ma-Lox for coating hot dry surfaces up to 1600 and 1200 F. Thurmalox Co. also manufactures the Thurco line of eight coatings for temperatures up to 800F. These new products will round out the Dampney line of specialized protective coatings for industrial applications which have heretofore featured coatings for hot-wet and cold-wet applications.

The **J. O. Ross Engineering Corp.** of New York was host to all its office employees and their wives at a dinner party at the Roosevelt Hotel and at a theater party the next evening. The events were in celebration of the firm's 25th anniversary and nearly 200 guests were present at the dinner party, including employees from offices in New York, New Brunswick, N. J., Boston, Chicago, Detroit, Los Angeles, and Canada.

Peerless Mfg. Corp. announces the return of **Thomas D. Bromley,** manager of the Gas-Fired Heating Equipment Division. Mr. Bromley has been serving with the United States Navy since October of 1943.

ABSTRACTS AND REVIEWS

ELECTRIC MOTOR CONTROL

All the motors in use today have some form of control, from the simple manual starter to the complex type for large installations. In order to make successful installations involving motors or to purchase them intelligently, some knowledge of motor control is essential.

Mr. P. B. Harwood in his book explains briefly the characteristics of various types of motors so that the reader will have a better understanding of the control problems involved. There is material on the design, construction and operating characteristics of a number of controllers and control devices. The problems of motor acceleration, dynamic braking and resistor design are discussed in detail.

Subject matter is divided into 20 chapters including those on direct current contactors and relays, alternating current contactors and relays, accelerating methods, magnetically operated brakes, variable-voltage controllers, resistor design and electronic motor control. Chapters on each of the common types of motors cover construction, ratings, starting, reversing, speed regulation, motor protection and control.

Here is a book that is highly recommended for engineers who desire to know more about electric motor control.

Control of Electric Motors, by P. B. Harwood. Cloth bound, 5½ x 8½ in., 479 pages. Published by John Wiley & Sons, Inc. Price, $5.

REFRIGERATION ABSTRACTS.—This publication which will appear as a quarterly, will attempt to abstract American and British literature and patents of interest to refrigeration engineers. It is published by the American Society of Refrigeration Engineers and is issued to members. A staff of 60 abstractors has been appointed. The first issue groups the abstracts under the heads of general, natural sciences, engineering, engineering materials, refrigerating media, thermal insulating materials, machinery and equipment, foods, refrigeration applications, patents. Available at the society, 40 W. 40th St., New York 18, N. Y. Price, $1.50 a copy.

NEW CATALOGS

Heating Book

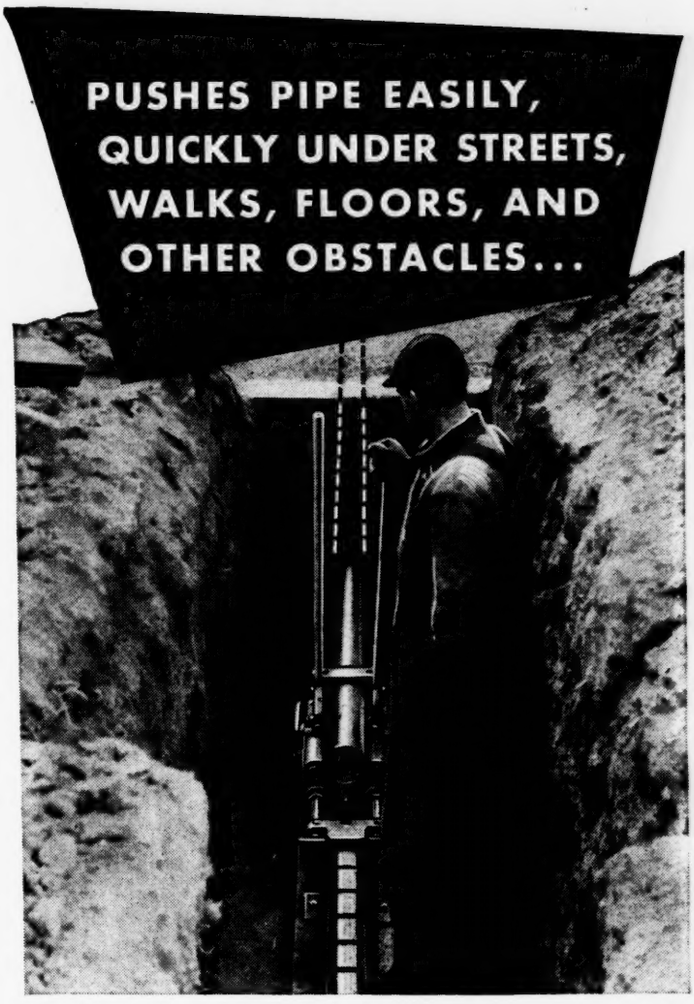
This booklet presents the first showing of the new line of oil-fired home heating units manufactured by The Heil Co., Milwaukee. Not "dressed up" pre-war models, these burners are said to be completely new from heat exchanger to casings. In the development of the new Heil units, a nation-wide survey of dealers and distributors gave them a voice in determining the most desirable features.—*The Heil Co., 3000 W. Montana St., Milwaukee 1, Wis.*

Base-Ray Panel Installations

A rating and installation guide for the new Base-Ray radiant baseboard, illustrated with 25 drawings and photographs, has been published.—*Burnham Boiler Corp., Irvington, N. Y.*

Fuel Oil Heaters

Bulletin No. 35 featuring fuel oil heaters. This bulletin is for use as a reference for heating engineers and others working on fuel oil combustion problems. Included is a viscosity-temperature chart which shows the temperatures required to reduce oil to the desired viscosity.—*The Whitlock Mfg. Co., Hartford 1, Conn.*



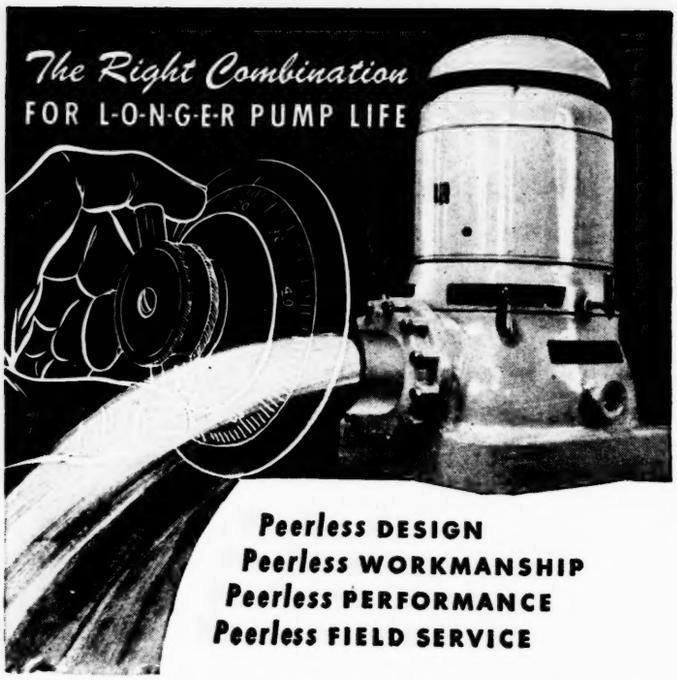
GREENLEE HYDRAULIC PIPE PUSHER

Here's how you can cut costs, save time on underground pipe installations. With a GREENLEE Hydraulic Pipe Pusher *one man* can push pipe through the ground *easily, quickly* — under obstructions!

Save the time, work and inconvenience to all caused by the old methods of tearing up floors, lawns and pavement. Eliminate tedious back-filling, tamping, tunneling, repaving (just a short trench accommodates the pusher).

Save with the GREENLEE which often pays for itself on the first few jobs used. Learn all about this compact, portable, powerful pipe installing equipment . . . get free Folder S-117. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2322 Twelfth St., Rockford, Illinois, U.S.A.

REGISTERED TOOLS
GREENLEE
FOR THE CRAFTSMAN



Peerless manufactures a complete line of Deep Well Turbine Pumps, Domestic Water Systems, and Horizontal Centrifugal Pumps (formerly Dayton-Dowd).

PEERLESS PUMPS

PEERLESS PUMP DIVISION
Food Machinery Corp.

FACTORIES
LOS ANGELES 31, CALIFORNIA
301 West Avenue Twenty-six
QUINCY, ILL. • CANTON 6, OHIO

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Reg. U. S. Pat. Off.

is known to Leading Heating and Ventilating Engineers as the

PERMANENT

Underground Pipe Conduit

It is Stronger
It is More Efficient
It is More Economical
It is Competitive in First Cost
It is Superior in Every Way

Bulletin 381 tells about the many outstanding advantages possessed by Therm-O-Tile. Ask for a copy.

Sold and installed by Johns-Manville Construction Units in all Principal Cities. See Sweet's Architectural File, or, The Heating Guide.

H. W. PORTER & CO., INC.

823-V Frelinghuysen Ave. Newark 5, New Jersey

Insulation

A 24-page, illustrated data book on Carey insulating materials including asbestos, diatomite, magnesia, and mineral wool. Contains conductivity and performance data on Carey piping insulation, structural and refractory materials, and miscellaneous allied products.—*The Philip Carey Mfg. Co., Lockland 15, Cincinnati, Ohio.*

Instrument Line

Catalog 370, presenting a line of recording and indicating instruments for measurement and control. Arranged for quick reference and illustrated, the sections deal with instruments for temperature applications, pressure, humidity, flow, liquid level, density, and other process variables. Control valves, planimeters, instrument accessories and supplies are included.—*The Foxboro Co., Foxboro, Mass.*

Airport Design

The Ric-wiL Co. has issued a project study entitled "Looking Ahead to the Airport Center of Tomorrow." The purpose of this study is to present the case for central heating at a modern airport center and to demonstrate how the application of this principle can affect the entire conception of airport design. It deals with a hypothetical airport designed to serve the hundreds of medium and smaller sized cities in the country, which at present do not have within themselves the population to support their own terminals for scheduled airline stops, but considered on a regional basis, they could be grouped so that combined populations would justify them. The thought is developed that this airport center strategically located on super highways and central to a number of municipalities could logically support retail establishments, amusement places, hotels, residences, manufacturing and warehousing activities. A Central Steam Plant removes the objections of chimneys, smoke and soot formerly associated with such construction at an airport.

Detailed information consisting of photograph illustrations, blue prints, cost data, etc., is presented to show that such a project is economically feasible. Copies of the book are available to anyone interested in airport planning. — *The Ric-wiL Co., Union Commerce Bldg., Cleveland, Ohio.*

Steel Boilers

Bulletin No. S-67 (Fifth Edition) covers standard electric welded steel boilers including smokeless and direct draft types, hand, stoker, oil and gas fired.—*The Brownell Co., Dayton 1, Ohio.*

Insulation

Baldwin-Hill Company has just released a new 4-page, fully-illustrated folder on their B-H No. 1 Insulating Cement. This 8½ x 11 folder provides factual information, tables and charts on the efficiency, coverage and ease of application of the product, which is described as the all-purpose thermal insulation.—*Baldwin-Hill Co., 564 Klagg Ave., Trenton 2, N. J.*

Pressure Chart for Small Tubing

This diagram is designed to show a safe working pressure for small hydraulic stainless steel tubing. Outside diameters from ⅛ in. up to 1 in.—wall thicknesses for .009 in. to .065 in.—ultimate tensile strength from 30,000 to 120,000 PSI—safety factors from two to six inclusive. The chart also shows the weight of stainless steel tubing in pounds per lineal foot. The diagram permits a direct reading of the ultimate pressure for any tube size within above specified limits. The chart was designed by Benjamin Ostlind, staff engineer of Baker Steel and Tube Co., Los Angeles, and is distributed by —*Summerill Tubing Co., Bridgeport, Pa.*

Air Conditioning

A 40-page catalog in color titled "Air Conditioning for Multi-Room Buildings." Advantages of air conditioning for hotels, hospitals, office and apartment buildings are told, and the five Carrier systems explained in photographs and charts. Copies may be obtained by sending a request on a business letterhead to Leslie M. Beals, director of advertising and sales promotion.—*Carrier Corp., Syracuse, N. Y.*

Leather Packings

Two folders. One describing an assortment of leather packings and showing tables of sizes and prices. The other presenting a table of standards governing the correct proportions and dimensions of leather packings for all purposes.—*Alexander Brothers, 406 N. 3rd St., Philadelphia 23, Pa.*

Moisture Engineering

A Kathabar System application chart based on the conventional psychrometric chart and using colors to denote the various zones of Kathabar application of humidification, dehumidification and cooling, carries an explanation of the use of the chart and on the reverse a reproduction of the General Electric psychrometric chart.—*Kathabar Division, Surface Combustion Corp., Toledo 1, Ohio.*

Plant Tour

"An Engineer Looks at ILG"—the title of a new 36-page book published by the ILG Electric Ventilating Co. of Chicago—tells the book's content in just five words. For the new publication is just that—a word and picture story of what a consulting engineer saw as he made a tour of the ILG plant. Starting out with manufacture of motors with special characteristics for ventilating equipment duty, a stop is made in the centrifugal fan department where both all-steel and fans with cast iron sides are in progress. Propeller fans with self-cooled motors are shown before and during assembly along a block long continuous conveyor system. Closely adjoining are photographs taken of vaneaxial fan construction. Two pages of pictures show the manufacture and assembly of unit heaters.—*Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago 41, Ill.*

Air Filter Data

A loose-leaf-type booklet presenting installation and performance data on replaceable type air filters. Booklet contains introductory remarks about throw-away filters in general and continues with a discussion of Research air filters with installation methods and capacity charts. —*Research Products Corp., Madison 3, Wis.*

Welded Fabrication

A new engineering manual entitled "Tailoring in Metal" discusses the factors affecting the choice of welded fabrication and the techniques of welded design. As stated by the author, the purpose of the manual is to help engineers and designers decide for themselves if fabrication by welding and the materials made available by this method are applicable to the problem. Various types of welds are explained, and how they affect static and fatigued load values.—*The United Welding Co., Middletown, Ohio.*

Safety and Relief Valves

Safety and relief valves to match the improved designs of the latest power and process equipment are announced in a catalog, No. 45, issued by the Farris Engineering Co. New valve designs, and improvements of old designs, now complete the line of safety and relief valves available from this company.—*Farris Engineering Co., 400 Commercial Ave., Palisades Park, N. J.*

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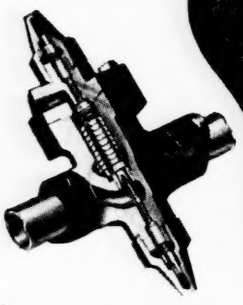

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INDUSTRIAL DEGREE-DAYS
December, 1945

City	55F Base	45F Base
Baltimore, Md.	670	364
Buffalo, N. Y.	967	657
Chicago, Ill.	939	630
Cleveland, Ohio	880	570
Detroit, Mich.	940	630
New York, N. Y.	747	439
Philadelphia, Pa.	716	410
Pittsburgh, Pa.	800	490
St. Louis, Mo.	820	518

CANADIAN DEGREE-DAYS FOR DECEMBER, 1945

City	December 1945	December Normal	Cumulative, Sept. 1 to Dec. 31 1945	Cumulative, Sept. 1 to Dec. 31 Normal
Calgary, Alta.	1566	1426	4192	3702
Charlottetown, P. E. I.	1271	1246	2837	2865
Crescent Valley, B. C.	1159	1240	3167	3279
Edmonton, Alta.	1792	1578	4645	3957
Fort William, Ont.	1730	1596	4105	3815
Grand Prairie, Alta.	1851	1649	4867	4159
Halifax, N. S.	1162	1338	2603	2815
London, Ont.	1380	1200	2936	2677
Medicine Hat, Alta.	1655	1417	3950	3389
Moncton, N. B.	1370	1373	3182	3186
Montreal, P. Q.	1476	1407	3275	3096
North Bay, Ont.	1665	1528	3830	3503
Ottawa, Ont.	1538	1494	3337	3277
Penticton, B. C.	1017	1073	2695	2626
Porquis Junction, Ont.	1857	1786	4379	4248
Prince George, B. C.	1355	1504	4011	3757
Quebec City, P. Q.	1510	1534	3390	3511
Regina, Sask.	1897	1779	4688	4336
St. John, N. B.	1293	1271	2947	2969
Saskatoon, Sask.	1906	1767	4741	4249
Toronto, Ont.	1252	1155	2692	2644
Vancouver, B. C.	825	818	2286	2168
Victoria, B. C.	735	738	2053	1910
Windsor, Ont.	1271	1172	2600	2446
Winnipeg, Man.	1931	1892	4447	4205

*These data are supplied through the courtesy of the Meteorological Division, Air Services Branch, Department of Transport, Canada, with the cooperation of N. W. Etter, Heating Engineer, Enamel & Heating Products Limited, Sackville, N. B.

The Department reports a slight revision in the figure for November for Halifax, N. S., as published in last month's issue. Corrected figure is 774.

CONVENTION REPORT

ASHVE

Heating and ventilating engineers meet in New York.

• 52ND.—The 52nd Annual Meeting of the American Society of Heating and Ventilating Engineers was held in New York, January 28-30, with registration headquarters at the Hotel Commodore and committee meetings at the Roosevelt.

Registration of 735 persons began on Monday, January 28, at 9:00 a.m., and ten technical papers were presented at the three technical sessions, including: A Study of Several Coal-Fired Magazine-Feed Space Heaters, by R. C. Cross and H. N. Ostborg; Application of High Temperature Liquid as a Heat or Energy Transfer Medium for Domestic and Industrial Uses, by O. O. Oaks; A Single-Equation Design Procedure for Radiant Panel Systems, by F. W. Hutchinson; Low Pressure

Properties of Water From —160 to 212F, by John A. Goff and S. Gratch; Therapeutic Uses of Low Temperature, by Frederick M. Allen, M. D.; Heating and Ventilation of Transport Aircraft, by B. M. Brod; Branch Take-Off Design and Its Effect on Noise in Duct Ventilating Systems, by O. Imalis, F. C. Houghten, and C. M. Humphreys; Combined Effect of Noise and of Hot Environments on Work Output, by M. S. Viteles and K. Smith; Physiological Effects of High Effective Temperatures and Elevated Mean Radiant Temperatures, by C. M. Humphreys. O. Imalis, and C. Gutberlet, and Shielding of Thermocouples from the Effect of Radiation, by G. W. Parmelee and R. G. Huebscher.

• **SOCIAL.** — The first social feature at the meeting was the welcome luncheon on Monday, at which R. H. Carpenter, General Chairman of Committee on Arrangements, was toastmaster. Harvey Wiley Corbett, prominent New York architect, spoke on the subject, "Are We Over Mechanizing Life?" At 6:30 p.m. on Monday was a Mardi-Gras party, consisting of dinner and carnival entertainment in the Hotel Capitol. A revue, staged by John Murray Anderson, was on the program. The main social function of the meeting was the annual banquet when W. H. Driscoll, past president of the society, acted as toastmaster. Presentation of the Past President's Emblem was made to the retiring president, as well as the presentation of the F. Paul Anderson Medal.

The Committee on Arrangements is as follows: R. H. Carpenter, **General Chairman; Vice-Chairmen** — M. C. Giannini, W. E. Heibel, H. S. Johnson, C. S. Koehler and H. J. Ryan; The chairmen of the various committees are: **Banquet** — Alfred Engle; **Entertainment** — M. C. Giannini; **Finance**—W. M. Heebner; **Inspection**—C. S. Pabst; **Ladies**—H. S. Wheller; **Publicity**—C. F. Roth; **Sessions**—E. J. Ritchie; **Reception**—H. J. Ryan; and Carl H. Flink, **Secretary.**

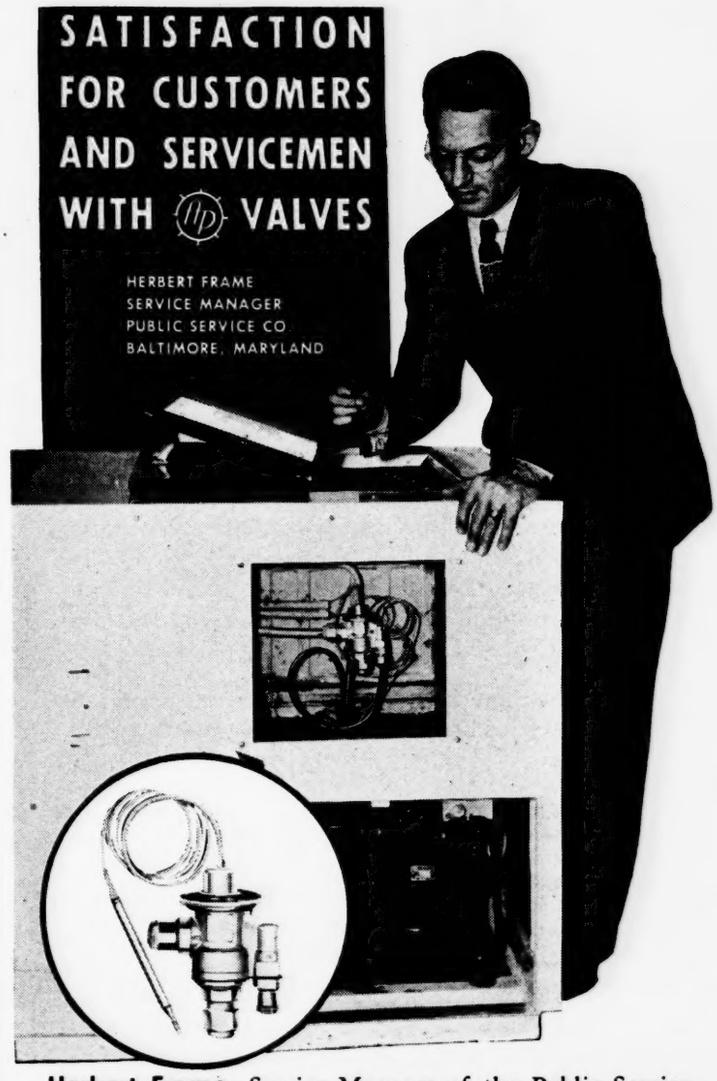
• **INSTALLATION.**—Alfred J. Offner, New York consulting engineer, was installed as 1946 president of ASHVE at the final session, January 30.

A. J. Offner

After teaching advanced physics for five years at Cooper Union where he received his formal education, Mr. Offner became associated with a number of professional consulting engineers and in 1930 opened his own office. He was president of ASHVE's New York chapter in 1930, and has been a member of the national society's council since 1935. He has served on various society committees and was second vice-president in 1943, and first vice-president in 1944. He is the author of numerous papers and articles on the subject of heating and ventilating.

B. M. Woods, Director of University Extension, University of California, was installed as first vice-president of the society. Dr. Woods has been associated with the University of California for 35 years, and in 1930 was appointed to the chairmanship of the Mechanical Engineering Department. In 1942 he became director of the University Extension. He served as president of the American Society of Planning Officials in 1943. Dr. Woods was instrumental in organizing the Golden Gate Chapter of ASHVE and served as its first president in 1937. He has been a member of the society's council since 1942, and is the author of numerous published articles and is co-author of books on engineering subjects. Besides being a member of the society, he is also a member of the New York Association of Consulting Engineers, serving as its president for two seasons in 1936 and 1937.

Other 1946 officers installed were G. L. Tuve, Case School of Applied Science, Cleveland, Ohio, second vice-president; and John F. Collins, Jr., Pittsburgh, Pa., treasurer.



Herbert Frame, Service Manager of the Public Service Co., of Baltimore, shown above, is checking the temperature of an ice-cream cabinet on test. A standard "A-P" Thermostatic Expansion Valve Model 207 is used on this job as standard equipment.

Writes Mr. Frame: "A-P Valves for high and low temperature work have been used by our company since 1936. Customers' satisfaction as well as servicemen's satisfaction has been accomplished by the use of A-P Valves during this period."

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